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REPORT

OF THE

COMMISSIONER OF FISH AND FISHERIES

RELATIVE TO

THE SALMON FISHERIES OF ALASKA.

JULY 5, 1892.—Referred to the Committee on Fish and Fisheries and ordered to be printed.

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KARLUK PENINSULA, SHOWING CANNERIES, SEINING OPERATIONS, AND KARLUK RIVER.

REPORT ON THE SALMON FISHERIES OF ALASKA.

By MARSHALL McDONALD,
U. S. Commissioner of Fish and Fisheries.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., July 2, 1892.

Hon. LEVI P. MORTON,
President United States Senate.

SIR: In obedience to a resolution of the Senate of the United States, directing the Commissioner of Fish and Fisheries "to communicate to the Senate any information in his possession relative to salmon fishing in Alaska, its extent, and whether the methods employed in catching salmon are likely to diminish the supply and eventually exterminate the salmon; together with his opinion as to what measures should be adopted for the protection and preservation of the salmon industry in Alaskan waters," I have the honor to transmit herewith a brief report, discussing the subject under the following captions:

1. Origin and development of the Alaskan salmon fisheries.
2. Statistics of the fisheries.
3. Present condition of the fisheries.
4. The methods and apparatus employed.
5. The protective regulation of the fisheries, including recommendations as to further legislation in reference to them.

Appended to this communication, and making a part of it, is a paper upon the life history of the salmon, by Dr. T. H. Bean, ichthyologist of the Commission. For convenience of reference I have also appended a bibliography, as far as could be ascertained in the limited time at my disposal, of publications relating to the salmon of Alaska and adjacent waters.

ORIGIN AND DEVELOPMENT OF THE ALASKAN SALMON FISHERIES.

The marvelous abundance of several species of salmon in Alaskan waters has been long known, but in consequence of the remoteness of this region and its inaccessibility, the abundant supply in rivers nearer markets, and a disposition on the part of buyers to underrate Alaskan products, its fishery resources have not been laid under contribution for market supply until within a few years, during which we have seen, as the result of reckless and improvident fishing, the practical destruction of the salmon fisheries of the Sacramento and the reduction of the take on the Columbia to less than one-half of what it was in the early history of the salmon-canning industry

on that river. At present the streams of Alaska furnish the larger proportion of the canned salmon which find their way to the markets.

The pioneer in the early development of the salmon-canning industry in Alaskan waters was the Alaska Commercial Company, which in 1887 established a cannery on Karluk River on the west side of Kadiak Island, and packed about 13,000 cases of salmon. The enterprise proved exceedingly profitable, and operations were rapidly extended so that the pack of this company on the Karluk River in 1888 aggregated 101,000 cases of 48 pounds each, representing a catch of over 1,200,000 bluebacks or red salmon in the estuary of a small stream, with a volume and drainage area not exceeding that of Rock Creek (the small stream flowing through the Zoölogical Park and discharging into the Potomac River within the city limits of Washington, D. C.). The enormous production of this year was secured by entirely obstructing the river by running a fence across so that no fish could pass up, and by continuing canning operations without intermission until late in October, when most of the fish were dark and unfit for food.

The immense pack made by the Alaska Commercial Company in 1887 and 1888, the fame of which quickly extended to San Francisco, had two important results. The attention of Congress was directed to the inevitable disaster that would overtake the salmon fisheries of Alaska unless prompt measures were taken to restrain the improvident and destructive methods employed for the capture of the salmon. Accordingly, upon the recommendation of the Commissioner of Fisheries, an act for the protection of the salmon fisheries of Alaska was introduced into Congress and became a law on March 2, 1892, as follows:

AN ACT TO PROVIDE FOR THE PROTECTION OF THE SALMON FISHERIES OF ALASKA.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than $250 for each day of the continuance of such obstruction.

SEC. 2. That the Commissioner of Fish and Fisheries is hereby empowered and directed to institute an investigation into the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions and methods of the fisheries, with a view of recommending to Congress such additional legislation as may be necessary to prevent the impairment or exhaustion of these valuable fisheries, and placing them under regular and permanent conditions of production.

SEC. 3. That section 1956 of the Revised Statutes of the United States is hereby declared to include and apply to all the dominion of the United States in the waters of Bering Sea; and it shall be the duty of the President, at a timely season in each year, to issue his proclamation and cause the same to be published for one month in at least one newspaper, if any such there be, published at each United States port of entry on the Pacific coast, warning all persons against entering said waters for the purpose of violating the provisions of said section; and he shall also cause one or more vessels of the United States to diligently cruise said waters and arrest all persons, and seize all vessels found to be, or to have been, engaged in any violation of the laws of the United States therein.

Approved, March 2, 1889.

This act, though authorizing and directing the Secretary of the Treasury to establish such regulations and surveillance as should be necessary to insure that the pro-

hibition would be enforced, neither prescribed the machinery nor appropriated the means to carry it into effect. Some restraint has doubtless been imposed upon attempts at violation of the law where they are likely to come under observation, but it is probably violated without hesitation or scruple where the chance of discovery is casual or remote.

STATISTICS OF THE FISHERIES.

The immense take of salmon in the estuary of the Karluk River in 1887 and 1888, had the additional result of attracting attention to a field promising such extravagant returns for the capital invested. More than 30 new canneries were established during the season of 1889. Five were located on the sand-spit at the mouth of the Karluk River, and 3 others so near as to draw their supplies from that source. Over 350,000 cases of red salmon, representing 4,000,000 of fish, were taken from this insignificant rivulet in 1889, and sent into the markets of the world. During this season there were 36 canneries in operation in Alaska, and the value of the salmon pack amounted to $3,375,000.

The following table, showing the Alaskan salmon pack from 1883, when systematic canning operations were first instituted, to 1890, after they had probably reached their largest development, is very interesting as well as suggestive; interesting, as illustrating the wonderful wealth of the waters; suggestive, because we know that it has been accomplished by irrational and destructive methods, and by improvident, willful, and contemptuous disregard of natural laws, whose aid and unobstructed operation are essential to the maintenance of a continuing and productive salmon fishery in Alaska.

The Alaska salmon pack from 1883 to 1890.

Year.	Number of cases.	Year.	Number of cases.
1883	36,000	1887	190,200
1884	45,000	1888	298,000
1885	74,850	1889	675,000
1886	120,700	1890	610,747

A review of the statistics of the salmon pack of Alaska from 1883 to 1890, compiled from data gathered by the division of fisheries of the U. S. Fish Commission, shows that the total yield of the salmon fisheries of this region from 1883 to 1890, both inclusive, was 2,050,497 cases of 48 pounds each, representing an aggregate production of 28,706,958 salmon within the period mentioned. During the first three years the pack was small, viz, 36,000 cases in 1883, 45,000 cases in 1884, and 74,850 cases in 1885. After this the increase in production was phenomenal, and in 1889 had reached the enormous amount of 675,000. Production in the subsequent years receded slightly, but the aggregate for 1890 and 1891 did not fall much short of the pack of 1889. Of the entire Alaskan yield, about one half is taken from the estuary of the Karluk River. Adding the product of 1891 to the aggregate for previous years, we have a total yield of canned salmon since 1883, when regular canning began, amounting to nearly 2,750,000 cases, and a total value of $11,000,000.

Besides the canned salmon, the rivers of Alaska yield annually nearly 7,000 barrels of 200 pounds each of salt salmon. When we add to the above production the enormous quantities of salmon which are consumed by the natives, in the fresh and dried condition, we shall be able to form some adequate idea of the immense value of the Alaskan salmon, and the importance of fostering and establishing conditions of permanence for this great resource.

In 1889 the salmon fishery gave employment to 66 vessels, including 13 steamers, 13 barks, 2 brigs, and 1 ship. Thirty-six canneries were in active operation, not counting a number of small establishments whose pack was light, and incidental to general trading with the natives. The capital stock of these canning companies ranged from $75,000 to $300,000. The estimated capital was $4,000,000, and the value of the pack $3,375,000.

PRESENT CONDITION OF THE FISHERIES.

OBSTRUCTIONS IN THE RIVERS.

Early in April, 1890, information reached the Commissioner of Fisheries in regard to a salmon trap, the construction of which had been determined upon by four cannery firms located on the Nushagak River. About 25 miles from the mouth of this river is a tributary known as Wood River, into which most of the salmon entering the Nushagak make their way for the purpose of spawning in the two large lakes at its head. Believing that such action was a violation of the act of Congress approved March 2, 1889, providing for the protection of the salmon fisheries of Alaska, the Commissioner transmitted the information to the Secretary of the Treasury with the suggestion that the necessary steps be taken by some of the Treasury officials in that region. The matter was referred to the chief of the Revenue-Marine division with the recommendation that if possible the captain of one of the Revenue-Marine steamers cruising in Alaskan waters be directed to make an investigation, and, if necessary, have the obstructions removed and the guilty parties arrested and prosecuted.

On April 12 the chief of the Revenue-Marine division returned the correspondence to the Commissioner of Fisheries with the information that the commanding officers of the Revenue-Marine steamers cruising in Alaskan waters during the ensuing season would be instructed to enforce the law for the protection of the fisheries as far as circumstances would permit. He suggested also that the commanding officer of the Fish Commission steamer *Albatross* be instructed to investigate the complaint and enforce the law if found necessary. Inasmuch as the Commissioner of Fisheries did not have authority to give directions for the enforcement of the law, he wrote to the chief of the Revenue-Marine division on April 17 that if the Secretary desired to confer the necessary authority upon the commanding officer of the *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, he would take pleasure in forwarding the same. On the following day, therefore, the acting Secretary of the Treasury, Hon. George S. Batcheller, forwarded to the Commissioner of Fisheries the following order, clothing the commander of the *Albatross* with the necessary authority to act in the matter, inclosing at the same time copies of Treasury circular of March 16, 1889, in relation to the matter.

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., April 18, 1890.

SIR: You are hereby clothed with full power and authority to enforce the provisions of law contained in act of Congress approved March 2, 1889, providing for the protection of the salmon fisheries of Alaska, which prohibits the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds.

Respectfully, yours,

GEO. S. BATCHELLER,
Acting Secretary.

Lieut. Commander Z. L. TANNER,
Commanding U. S. Fish Commission Steamer Albatross,
San Francisco, Cal.

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., March 16, 1889.

TO COLLECTORS AND OTHER OFFICERS OF THE CUSTOMS:

The following provision of the act approved March 2, 1889, entitled "An act to provide for the protection of the salmon fisheries of Alaska" is hereby published for the information and guidance of all concerned:

"That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than $250 for each day of the continuance of such obstruction."

Collectors and other officers of the customs, and officers under the jurisdiction of this Department who may be assigned to duty in Alaska, will see that the requirements of said section are strictly observed, and that no dams, barricades, or other obstructions are placed in any of the rivers of Alaska with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds; and should any such dams, barricades, or other obstructions be discovered, to warn the persons who erected the same to immediately remove them and thereafter report the persons (with statement of facts) to the United States attorney of Alaska for prosecution under the said section, and also to forward duplicate reports to this Department for its information.

Officers of the Revenue-Marine Service on duty in Alaskan waters are hereby required, so far as practicable, to assist officers of the customs in Alaska in seeing that the requirements of the statute are strictly enforced.

HUGH S. THOMPSON,
Acting Secretary.

On April 23 a letter of instructions was forwarded to Lieut. Commander Tanner, calling his attention to the existence of a trap or dam on Wood River, as also to the order of the Secretary of the Treasury directing the Revenue-Marine steamers to enforce the law as far as circumstances would permit, and to the request that the steamer *Albatross* make an investigation and carry out the provisions of the law in case of its violation. Lieut. Commander Tanner was directed to make this one of the first objects of his cruise in Bering Sea, and to comply with the instructions of the Secretary of the Treasury as fully as possible. The report of Lieut. Commander Tanner, after making the investigation, was as follows:

UNALASKA, ALASKA TERRITORY, *June 15, 1890.*

Hon. MARSHALL MCDONALD,
U. S. Commissioner of Fish and Fisheries, Washington, D. C.:

DEAR SIR: I have the honor to inform you that the *Albatross* anchored in the Nushagak River on June 3. I visited the four canneries located on that stream the following day. They use gill nets

almost exclusively in taking salmon, although three of them have a small trap in the immediate vicinity of their establishments. They are all dry at low tide, and when fish are found in them men go in and pick them up from the ground.

The fourth cannery had a trap formerly, but did not find it profitable. Nothing that can be called an obstacle to the free passage of salmon exists in the Nushagak River.

I learned from Mr. J. W. Clark, one of the projectors, and others, that a union trap was in process of construction in Wood River, and in order to ascertain the character and present condition of the work I took Mr. P. H. Johnson, who has charge of the enterprise, and Mr. Clark, in one of the ship's boats, and steamed to the point indicated, which I found to be about 20 miles above its mouth.

Wood River at that point is a stream of pure cold water between 700 and 800 feet in width and 10 feet deep at low tide; rise, 3 to 4 feet.

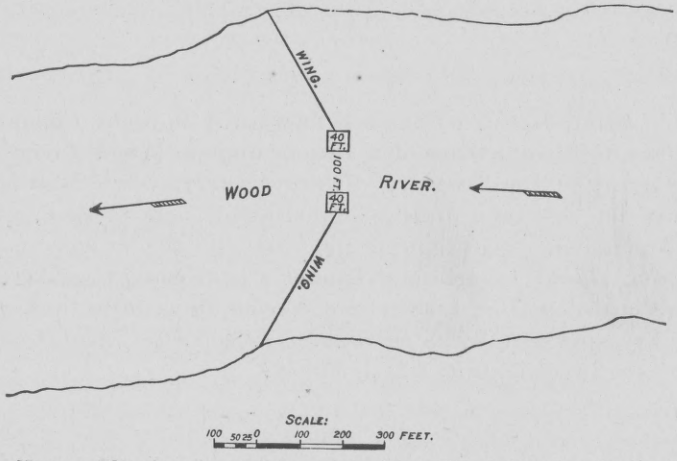
The work of trap-building was in progress, a group of ten piles having been driven about 300 feet from shore, and lying on the bank were a portion of the nets required to mount the finished structure. Operations were not sufficiently advanced to enable me to judge their intention, and I can only give the plan as detailed to me by the builders. Mr. Clark stated that the plans contemplated two 40-foot square traps, with wings extending to the shore on either side, an open channel of 100 feet being left in midstream for the passage of the salmon; that he had joined the enterprise with the stipulation that this passage should be left unobstructed at all times.

In reply to a question, he said that he had lived in the country many years as a fur-dealer, and the thickly populated region on Wood River contained many of his best customers; hence he would have no hand in anything that would injure them. An obstruction in the river preventing the run of salmon would result in actual starvation to the majority of the natives.

Mr. P. H. Johnson, the prime mover in the affair, described the plans precisely as Mr. Clark had done. He considered the traps as an experiment involving too much money to be expended by either of the canneries singly; hence, he had endeavored to interest all four, and finally succeeded, Mr. Clark having joined them with the provision that a free passage of at least 100 feet should be left in the middle of the river. He said this stipulation was agreed to willingly, as they never had an idea of barricading the stream. The inclosed sketch shows the plan as given to me by the gentlemen mentioned; and the blue prints [not reproduced] give an accurate idea of the present state of the structure. It will be observed that, while a 100-foot channel will serve for the ascent of salmon, complete barricade of the stream can be accomplished with a net of that length, 12 to 15 feet in depth. Whether this simple appliance will be used depends, in the absence of a Government inspector, upon the canners themselves.

Very respectfully,

Z. L. TANNER,
Lieutenant Commander, U. S. Navy, Commanding.



NOTE.—The river is at this point about 750 feet wide; depth at mean low water, 10 feet; rise, 3 to 4 feet.

UNALASKA, ALASKA TERRITORY, *June 18, 1890.*

Hon. MARSHALL MCDONALD,

U. S. Commissioner of Fish and Fisheries:

DEAR SIR: In looking over my letter regarding the construction of traps in Wood River it occurs to me that I may not have explained my action very definitely. It is generally understood here that the act of March 2, 1889, does not prohibit the ordinary use of the trap, and that when a practicable channel is left for the passage of salmon they may lawfully be used. As I did not feel fully competent to argue the point I advised them to keep within the law, as the Government intended to enforce it strictly and would exact the full penalties for its infraction.

If it is the intention of the act to prohibit the use of traps, I would respectfully suggest that it be so stated in a Treasury circular. It would simplify matters very much if the Treasury Department would state definitely what the canners may or may not do under the act of March 2, 1889.

Very respectfully,

Z. L. TANNER,
Lieut. Commander, U. S. Navy, Commanding.

This correspondence was referred to the ichthyologist of the Commission, who made the following report:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., July 24, 1890.

Col. MARSHALL MCDONALD,

U. S. Commissioner of Fish and Fisheries:

SIR: After having considered the letters of Lieut. Commander Z. L. Tanner, U. S. Navy, dated June 15 and 18, 1890, referring to the construction of a trap in Wood River, Alaska, I respectfully offer my opinion that such a contrivance for the capture of salmon is of the nature of an obstruction which would impede and, in all probability, prevent the ascent of salmon to their spawning-grounds. It is, therefore, clearly a violation of the act approved March 2, 1889, a portion of which is quoted herewith:

[PUBLIC No. 158.—An act to provide for the protection of the salmon fisheries of Alaska.]

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than $250 for each day of the continuance of such obstruction."

It has been demonstrated that traps in salmon rivers will speedily exterminate the salmon. Newfoundland furnishes a satisfactory illustration of this fact. So well is this matter understood that British Columbia forbids altogether the capture of salmon in narrow reaches of streams, and the rivers are guarded to see that the close time and other regulations are observed; the length of nets and their size of mesh are fixed by law; even the offal from canneries is not allowed to lie in the way of ascending fish.

The Alaskan salmon firms are in the territory to get fish. They prefer to get them without injury to the future of the business if possible, but get them they must or be overcome by financial disaster. In their efforts to win success they have often stretched nets across the mouths of small streams and prevented the salmon from going up until a sufficient number had collected to make a good seine haul possible. They have erected traps in rivers in such a way as to stop every salmon from ascending and, in some cases, actually built impassable barricades to prevent the ascent of fish entirely until the demands of the canneries were satisfied. Even when fishing regulations were adopted by mutual agreement among the firms interested, individual infractions of the rule were only too frequent.

The trap men on Wood River are building upon the well-known habit of the quinnat (or king salmon) of following along the shores in shallow water to escape from enemies. All the conditions, both natural and invented, will favor the entrance of salmon into the great inclosure at the end of the leader of netting. In all probability few salmon will swim in midchannel and reach the upper

waters and lake sources of the river, and it will always be possible to cut off this remnant in the manner suggested by Lieut. Commander Tanner and actually practiced by fishermen on occasions, that of stretching a seine across the open water. If the Government should interpret its act so as to allow the use of traps, in spite of the unfortunate outcome of such appliances in neighboring countries, it should then prescribe regulations for the conduct of the fishery and appoint agents to see that the laws are enforced. If these matters are left solely to the discretion of the individuals having a financial interest in the fishery there will soon be no salmon to protect.

Very respectfully,

T. H. BEAN,
Ichthyologist, U. S. Fish Commission.

The papers relating to the obstruction of Wood River were transmitted to the Secretary of the Treasury by the Commissioner of Fish and Fisheries with the following letter:

WASHINGTON, D. C., *July 31, 1890.*

The SECRETARY OF THE TREASURY, *Washington, D. C.:*

SIR: Referring to your communication of April 18 last, forwarding to Lieut. Commander Z. L. Tanner, U. S. Navy, commanding the Fish Commission steamer *Albatross* on the Pacific coast, a letter clothing him with full power to enforce the provisions of the Alaskan salmon law, with special reference to obstructions which it was reported were to be constructed in the Nushagak and Wood rivers, I have the honor to transmit herewith for your consideration several documents bearing upon that subject, namely:

Copies of two letters from Lieut. Commander Z. L. Tanner, with their inclosures, dated Unalaska, Alaska, June 15 and 18, and a copy of a letter from Dr. T. H. Bean, ichthyologist of the U. S. Fish Commission, dated July 24.

Lieut. Commander Tanner reports having visited the Nushagak and Wood rivers on June 3. He found no obstructions in the former river, but in the Wood River two traps were in process of construction, with wings leading to the shore and leaving a passageway in the middle of the river 100 feet wide. Not feeling competent to judge if these traps formed an obstruction to the ascent of salmon within the meaning of the law, Lieut. Commander Tanner did not feel justified in carrying out the provisions of the law without further instructions from Washington.

Dr. T. H. Bean, whose letter is inclosed, may be considered as one of the foremost authorities in this country respecting the habits of the Alaskan salmon. He paid special attention to that subject during two official visits to Alaska, the last visit having been made a year ago, in obedience to instructions from Congress contained in the act of which the law now referred to forms a part. In his opinion the building of the traps in Wood River according to the plan submitted by Lieut. Commander Tanner should be regarded as an infringement of the law, and in that opinion I fully concur.

Should you desire to have further instructions respecting this matter sent to Lieut. Commander Tanner, I shall be pleased to transmit the same without delay, although, on account of the imperfect mail arrangements with Unalaska, I fear they may not reach him before the close of the season.

Very respectfully,

M. MCDONALD,
Commissioner.

To the foregoing communication the Acting Secretary of the Treasury made the following reply:

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., August 13, 1890.

Hon. MARSHALL MCDONALD,
U. S. Commissioner of Fish and Fisheries, Washington, D. C.:

SIR: I respectfully acknowledge the receipt of your letter dated July 31, 1890, with the following inclosures:

Copies of two letters from Lieut. Commander Z. L. Tanner, U. S. Navy; one sketch and two blue prints of Wood River, Alaska, and one letter from Dr. T. H. Bean, ichthyologist, U. S. Fish Commission.

The correspondence above mentioned has been carefully reviewed, and you are informed that it is the decision of this Department that the erection of traps as described by Capt. Tanner, or any other

permanent fences, dams, or barricades in any of the rivers of Alaska, whether they extend wholly or only in part across said stream, is an impediment to the ascent of salmon or other anadromous species to their spawning-grounds, and is clearly a violation of the act of March 2, 1889.

The Department will be pleased if you will inform Lieut. Commander Tanner of its decision in this case and instruct him to warn the parties who erected said traps, or any others of like nature that may come to his notice, to immediately remove the same, and thereafter to report the persons, with statement of facts, to the United States attorney of Alaska for prosecution under act March 2, 1889, and also to forward a duplicate of his report to this Department for its information.

Respectfully yours,

O. F. SPAULDING,
Acting Secretary.

The following communication was therefore transmitted to Lieut. Commander Tanner, advising him of the ruling of the Treasury Department:

WASHINGTON, D. C., *August 15, 1890.*

Lieut. Commander Z. L. TANNER,
Commanding Fish Commission Steamer Albatross,
Unalaska, Alaska:

DEAR SIR: Your letters of June 15 (179) and 18 (182), relative to your visit to the Nushagak and Wood rivers in respect to reported obstructions to the ascent of salmon, came duly to hand and were referred to the Secretary of the Treasury for his information. In connection with them, I also transmitted to the Secretary of the Treasury a report by Dr. Bean based upon your letters and describing the inevitable effect of the construction of such traps as those now being constructed in the Wood River. A copy of Dr. Bean's report is herewith inclosed, and also a copy of a letter just received from the Acting Secretary of the Treasury, in which a decision is rendered that the Wood River traps are a violation of the act of March 2, 1889.

Should this communication reach you in time you will proceed to carry out the request of the Treasury Department as stated in the letter of the Acting Secretary.

Very respectfully,

M. MCDONALD,
Commissioner.

LIMITATION OF THE SALMON CATCH BY AGREEMENT OF THE CANNERS.

The restrictions and embarrassments imposed upon the operations of the canneries by the act of Congress prohibiting the erection of barriers to the ascent of salmon in the rivers, and the decision of the Secretary of the Treasury that the erection of traps or any other permanent fences, dams, or barricades in any of the rivers of Alaska, whether extending wholly or only in part across said streams, was an impediment to the ascent of salmon and other anadromous species to their spawning-grounds, and therefore unlawful, changed the methods and apparatus of the fisheries, but brought no relief or immunity from the threatened disaster, since the methods substituted exclude the salmon from their spawning-grounds as effectually as if permanent obstructions were maintained in the rivers.

The pack of 1891 fell but little short of the enormous pack of 1889, and the accumulated stock of 1889, 1890, and 1891, being in excess of the demands of the market, had its natural result in causing a break in prices, which proved disastrous to many of the canneries and led to a combination of interests for the purpose of reducing production. An agreement to limit the catch was entered into by the canners of Alaska and British Columbia, which was put in operation the present season.

This limitation of the salmon catch by agreement places a check upon excessive fishing in Alaska. The effect will be conservative, although the measure was actuated

by selfish motives and may be abrogated at any time when prices recover under the stimulus of increased demand.

Before the opening of the salmon fishery in 1891 it was reported that 600,000 cases of canned salmon were in San Francisco warehouses and that in London about 400,000 cases which had passed into second hands were still on the market. This represents about two-thirds of the total average annual output of the Pacific coast. Finding that the market was overstocked and the price of canned salmon reduced in consequence, so that in many cases business became unprofitable, the canners decided to make a combination and curtail the fishing in the season of 1892. The output of the canneries of Alaska and the Pacific coast canneries for 1891 has been tabulated as follows:

	Cases.
Columbia River	390,000
Outside Oregon Rivers	20,000
Puget Sound	20,000
Fraser River	225,000
British Columbia and elsewhere	235,000
Alaska	800,000
	1,680,000

It was expected that the organization of the canners would include those of California and British Columbia as well as Alaska. The first subject of agreement was the reduction of the output to one-half of the usual quantity. By this means the canners hope to improve the trade, especially in the English market. The canners are under heavy bonds to keep the agreement and at the end of the season to declare under oath the amount of their packs. Of the thirty-seven canneries in Alaska only nine will be operated, and the men usually employed in the other establishments will not be hired. The same reduction will be made in California and British Columbia. In Alaska the intention was to operate two canneries at Karluk, two on the Nushagak, one at Chignik Bay, one at Cook Inlet, one either at Loring or Chilkat, one at Alitak Bay, and one at Copper River. The Alaskan output is to be limited to 400,000 cases.

The following agreement was entered into March 25, 1892, between the salmon-canners of Fraser River, Skeena River, Rivers Inlet, and elsewhere in British Columbia:

Whereas, on account of the overproduction of canned salmon on this coast, the markets of all salmon points in the United States, Canada, and Great Britain are overstocked with canned salmon, and it is desirable in the mutual interests of the parties to this agreement that some limitation in the pack of the coming season should be agreed to, in order that the supply of and demand for that article may be equalized; the several parties hereto have agreed to limit the pack of canned salmon at the canneries owned, controlled, or operated by them and each of them respectively upon the terms and in proportion hereinafter mentioned, as follows, viz: That the reduction in the pack of canned salmon during the season of 1892 shall be upon the Fraser 50 per cent upon the capacity of each cannery, and on the Skeena River and northern points 25 per cent upon the capacity of each cannery.

The salmon-canners on Kadiak Island constitute the following eight companies: The Karluk Packing Company, the Kodiak Packing Company, the Aleutian Island Fishing and Mining Company, the Hume Packing Company, the Arctic Packing Company, the Royal Packing Company, the Russian-American Packing Company, the Alaska Improvement Company.

The capital is upward of $2,000,000. In 1890 they employed 550 men to can 260,000 cases of salmon of 48 pounds each. In 1891 they proposed to reduce the force of men to 160, and still increase the take of salmon. They agreed to employ the same force of fishermen and to appoint a superintendent to see that each day's catch was equally divided among the eight companies. Each cannery was to be allowed the privilege of using private labels as before. The object of this consolidation was not to raise the price of the salmon, but to reduce the cost of taking it, in order to compete with the other thirty canneries and make money. In 1889 three canneries were located on Chignik Bay, and their catch was enough to pay only one, so they employed only one force of fishermen, and the yield in 1890 showed the wisdom of the plan. The title of the association is "The Board of Managers of the Karluk Canning Companies." The president of the board is Leon Sloss, jr., of the Alaska Commercial Company, and the secretary, Leon Maison, of the firm of Geo. W. Hume & Co. The following account of the organization and its operations in 1891 was furnished by Mr. Wm. H. Brommage, of Alameda, California.

Early in 1891 representatives of the various canneries in Alaska held a meeting under the title of "The Board of Managers of the Karluk Canning Companies" with the object of devising means to conduct fishing operations with less expense than usual, intending to put up 250,000 cases. They formed a combination as follows: The Arctic and Kodiak, the Hume and Aleutian Island, the Karluk and Royal, the Alaska Improvement and Russian American.

The pack was to be divided according to the capacity of each cannery; for example: Arctic and Kodiak, $\frac{72}{250}$; Hume and Aleutian, $\frac{75}{250}$; Karluk and Royal, $\frac{58}{250}$; and Alaska Improvement and Russian American, $\frac{45}{250}$. Independent of this, the Kodiak, Russian American, and Royal Packing Companies combined and were to put up fish caught at Little River and Afognak, which was not to be included in the Karluk pack. They employed 61 white men. The larger combination employed 160 men for Karluk, wages $60 for round trip and $12.50 per thousand fish.

Mr. Brommage made inquiry at the headquarters of the Board of Managers of the Alaska Canning Companies on February 24, 1892, and found that 800 men were looking for employment and that only 100 would be engaged, and that only the most experienced of them would be selected. These would be distributed to all the different stations in Alaska. He was informed that only 20 men would be sent to Karluk.

APPARATUS AND METHODS OF THE FISHERIES.

Gill nets, traps, and seines are employed in the capture of salmon, but the greatest bulk of the catch is made by haul seines, which sweep the estuaries of the small rivers, in which the larger part of the salmon catch is made, or are laid out from and landed on the beach proper immediately adjacent to the mouth of the river. One seine follows another in such rapid succession as to cover all approaches to fresh water, and the movement of the salmon into the rivers is as effectually arrested as if permanent barriers were maintained across the entire width of the stream. Gill nets may be used with the same results by stretching them from bank to bank. Traps, indeed, may be so skillfully located in accordance with the habits and movements of the salmon as to form effectual barriers to the upward movement of salmon in the rivers, though invading only in part the channel. Any or all of the different methods

here indicated may be employed with such persistence and under such conditions as completely to arrest the movement of the salmon into and up the streams.

The methods at present practiced by the canneries for obtaining a supply of salmon have an influence in bringing about the impoverishment of these important fisheries which can only be understood by a clear apprehension of their relations to the habits and migrations of the species which are the object of the fishery. A separate paper prepared by Dr. T. H. Bean, ichthyologist of the Commission, upon "The Life History of the Salmon," is therefore appended to and made a part of this report. The account of the distribution, migrations, habits, times, and essential conditions of natural reproduction there given will furnish the explanation and reason for such recommendations of further legislation as may be submitted.

SPECIES OF SALMON OF ECONOMIC VALUE.

The species of salmon found in Alaska in quantities sufficient to constitute an economic resource are: The red salmon (*Oncorhynchus nerka*), the king salmon (*Oncorhynchus chouicha*), the silver salmon (*Oncorhynchus kisutch*), the humpback salmon (*Oncorhynchus gorbuscha*), the dog salmon (*Oncorhynchus keta*), the steelhead (*Salmo gairdneri*), and the dolly varden (*Salvelinus malma*).

The Red Salmon.—This species at present constitutes the principal motive and object of canning operations. The southern limit of its range is the Columbia River, in which it is known as the blueback salmon. Its range extends northward to the Yukon River, and it makes its appearance in southern Alaskan waters early in June, the run beginning later as we proceed farther to the north. Schools of salmon continue to arrive until October and, after tarrying a short time in the coast waters, begin to ascend to their spawning-grounds, which are in the cold, snow-fed lakes from which issue the headwaters of the streams which are frequented by this species for the purpose of reproduction. The run is confined chiefly to the smaller streams, such as the Karluk, in which they crowd in numbers absolutely incredible to one who is not an eye-witness, and actually force each other out of the water in their eager struggles to reach the sources of the rivers and deposit their spawn.

The King Salmon.—This is the principal canning species of the Columbia and other rivers of Oregon and California, but at present it has relatively little importance in the Alaskan salmon fisheries. It is distinctively the salmon of the larger rivers, like the Yukon, on which the canning industry has not yet attained much development. It is, however, an abundant species, and with the growth of the canning industry on the larger rivers will attain great commercial importance.

The Silver Salmon.—This species is in great request for canning in the Puget Sound region, but is not held in much esteem by the canners of Alaska, because it becomes soft very soon after its capture and can not be kept like the red salmon. It spawns in the fall of the year, but does not make its appearance on the coast until shortly before canning operations close for the season, and, consequently, the opportunity for natural reproduction is more favorable than for the red salmon or king salmon. The species is abundant now, and under present conditions of the fisheries will doubtless maintain itself. The flesh, though not highly colored, is probably not inferior in table qualities to that of the red salmon, and in the future, with the extension of canning operations, it will doubtless be utilized more extensively than at present.

The Humpback Salmon.—This is the smallest, the most abundant, and most widely distributed species of the Alaskan salmon. It arrives on the coast of Kadiak from the 1st to the 10th of July, and continues to run for about five weeks, the height of the spawning season being early in August. It does not ascend far from salt water, and usually enters streams which are too shallow to cover its back fins. This species is not much used at present for canning purposes, but is dried by the natives in great quantities for winter use, and moderately large numbers are salted for the San Francisco and other markets. When fresh run its flesh is not inferior in edible qualities to that of the red salmon, and has a beautiful red color, but rapidly deteriorates after it enters the estuaries of the rivers. This species, from its abundance and wide distribution, will attain great commercial importance when its good qualities are better known.

The Dog Salmon.—This species occurs very abundantly in the small rivers and creeks of the islands and the main land. It makes its appearance at Kadiak about the middle of June and continues abundant for a month, after which the numbers rapidly diminish. It leaves the coast with the first appearance of ice. The flesh of this species will hardly ever be in request for canning, but it is one of the most important species to the natives, who dry it for winter use.

REPRODUCTION AS RELATED TO METHODS.

The species of salmon above enumerated, though differing in their seasons of reproduction and in their spawning habits and requiring different conditions and environment, are all subject to the restraint of one common law: they must have access to their natural spawning-grounds in the rapids of the rivers or in the cold, snow-fed lakes from which they issue; and in this natural law is to be found the suggestion of such legislation as may be necessary "to maintain the salmon fisheries under permanent conditions of production."

Whether these fisheries shall continue to furnish the opportunity for profitable enterprise and investment depends upon the policy to be inaugurated and maintained by the Government. Under judicious regulation and restraint they may be made a continuing source of wealth to the inhabitants of the Territory and an important food resource to the nation; without such regulation and restraint, we shall have repeated in the Alaskan rivers the story of the Sacramento and the Columbia; and the destruction in Alaska will be much more rapid because of the small size of the rivers and the ease with which salmon can be prevented from ascending them. For a few years there will be wanton waste of that marvelous abundance, which the fishermen—concerned only for immediate profit and utterly improvident of the future—declare to be inexhaustible. This season of prosperity will be followed by a rapid decline in the value and production of these fisheries, and a point will be eventually reached where the salmon-canning industry will be no longer profitable.

PROTECTIVE REGULATION OF THE FISHERIES.

Whatever may be the particular regulations and requirements it shall be found necessary to impose in the prosecution of the salmon fishery in order to maintain the supply, it is essential they should provide either that a considerable proportion of the run into the rivers shall be permitted to pass up and accomplish natural reproduction in the lakes and tributary streams, which afford feeding-grounds for the young salmon

during the period of their sojourn in fresh water, or that artificial propagation of the young and their distribution to the headwaters of the streams shall be prosecuted on a scale adequate to compensate for the interference with and the curtailment of natural reproduction by the operation of the fisheries.

If it be the policy of the Government to depend upon natural reproduction to maintain supply, this can be made effectual only by the enactment and enforcement of such regulation of the fisheries as will assure adequate reproduction under natural conditions. The different agencies which may be invoked, either separately or in conjunction, to accomplish this end are:

(*a*) A weekly close season from Saturday evening to Monday morning.
(*b*) A close season during September and October of each year.
(*c*) The establishment of national salmon parks or salmon reservations, as proposed by Dr. Livingston Stone.
(*d*) Absolute prohibition of the capture of salmon by the use of nets or other apparatus within 100 yards of the mouth of any river.
(*e*) The prohibition of the use of more than one seine in the same seine berth.
(*f*) The leasing of the privilege of taking salmon and the limitation of the catch, in accordance with the recommendation of the Commissioner of Fish and Fisheries, based upon continued and careful investigations of the conditions of the fisheries.

The establishment of a weekly closed season will assure that some proportion of the run will succeed in reaching their spawning-grounds, will of course have a conservative influence in keeping up supply, will render slower the depletion of the waters, and will probably prevent the extermination of the salmon.

The establishment of a close season during September and October will permit the schools of salmon approaching the coast during this period to enter the rivers and spawn unmolested. The conservative influence of this measure will depend of course upon the number of salmon which approach the coast only after the opening of the close season.

The establishment of national salmon parks or salmon reservations, as proposed by Dr. Livingston Stone in a paper read before the American Fisheries Society, would be an important factor in maintaining production and could be accomplished with relatively little cost. The importance of this agency as a means of maintaining the supply is so interestingly and forcibly presented by Dr. Stone in the article referred to that it is deemed appropriate to reproduce it here as published in Forest and Stream of June 16, 1892:

A NATIONAL SALMON PARK.

[A paper read before the American Fisheries Society.]

Who would have thought thirty years ago that the creation of a national park in this country would be the means of rescuing the buffalo from extinction? Who thought then that anything was needed to rescue the buffalo? The buffalo roamed in myriads over the plains and mountain slopes of the central portions of the United States and were so innumerable that, with the exception of a few far-sighted persons, no one thought that this noble race of animals was even in danger. The supply seemed inexhaustible and the species at least safe from extinction.

How soon we found out our mistake and how suddenly the change came. The note of alarm had hardly been sounded long enough to be distinctly comprehended over the country before the buffalo were gone—all gone practically, except a few straggling survivors which, if they had not found refuge

in Yellowstone Park, would have been gone, too, long before this. The Yellowstone National Park saved them. It saved the wild race from extinction, and, if nothing else should ever be accomplished by the creation of the park, this alone would, in the writer's estimation, justify its existence.

But if any one had said thirty years ago, "Let us form a national park in the buffalo region for a protection and refuge for the buffalo," the proposition would have been laughed down from one end of the country to the other. It would have been thought a most ridiculous expedient, a scheme too foolish and crazy to be even seriously entertained. Nevertheless, the creation of the National Park has accomplished this very object, and has been, I think it may be safely said, the only means of accomplishing this most important object, the preservation of the American buffalo.

Now what this paper is going to propose will appear, doubtless, just as ridiculous, just as foolish and crazy, as the formation of a park for the preservation of the buffalo would have been thought thirty years ago. It is nothing less than the creation of a national park for the preservation of our salmon.

I hear already from all directions the question "What do the salmon need a park for? Are there not plenty of places of safety for them already in all the rivers and streams of this country, not to mention the pathless ocean, where man can not follow them?"

It looks so at first sight, I admit; but let us try to find these places of safety if they exist, and then see how it looks. We certainly can not find them on the Atlantic coast, where the scanty yield of the only two American salmon rivers—the Kennebec and the Penobscot—is only a drop in the bucket compared with the total consumption of salmon. Passing over to the Pacific coast we find only the Sacramento, the Columbia, and the lesser streams on the Washington and Oregon coast, and in all these the salmon are about as safe as the fur seals were last year in Bering Sea.

I will say from my personal knowledge that not only is every contrivance employed that human ingenuity can devise to destroy the salmon of our west-coast rivers, but more surely destructive, more fatal than all is the slow but inexorable march of those destroying agencies of human progress, before which the salmon must surely disappear as did the buffalo of the plains and the Indian of California. The helpless salmon's life is gripped between these two forces, the murderous greed of the fishermen and the white man's advancing civilization, and what hope is there for the salmon in the end? Protective laws and artificial breeding are able to hold the first in check, but nothing can stop the last.

To substantiate this statement, which may seem exaggerated, let me inquire what it was that destroyed the salmon of the Hudson, the Connecticut, the Merrimac, and the various smaller rivers of New England, where they used to be exceedingly abundant? It was not overfishing that did it. If the excessive fishing had been all there was to contend with a few simple laws would have been sufficient to preserve some remnants at least of the race. It was not the fishing, it was the growth of the country, as it is commonly called, the increase of the population, necessarily bringing with it the development of the various industries by which communities live and become prosperous. It was the mills, the dams, the steamboats, the manufactures injurious to the water, and similar causes, which, first making the streams more and more uninhabitable for the salmon, finally exterminated them altogether. In short, it was the growth of the country and not the fishing which really set a bound to the habitations of the salmon on the Atlantic coast.

Let me illustrate this same statement more in detail by presenting the testimony of the salmon rivers of the Pacific coast. Take for an example the Sacramento. When the first rush of gold-seekers came to California in 1849, every tributary of the Sacramento was a fruitful spawning-ground for salmon, and into every tributary countless shoals of salmon hastened every summer to deposit their eggs. When the writer went to California in 1872, only twenty-three years later, not one single tributary of the Sacramento of any account was a spawning-ground for the salmon except the McCloud and Pitt rivers in the extreme northern part of the State, where the hostility of the Indians had kept white men out. It was not fishing by any means that had caused the disappearance of the salmon, for the miners did very little fishing in those times; but it was the débris from the quartz mines which drove the salmon out, ruining the spawning-grounds and rendering the river uninhabitable for the salmon.

This was in 1872. In 1878 the writer took 14,000,000 of salmon eggs from the summer run at the United States salmon station on the McCloud River. In 1883 the Southern Pacific Railroad Company (then the Central Pacific) extended their line northward up the Little Sacramento, crossing the mouth of Pitt River, into which the McCloud empties, a mile or two above.

So disastrous to the salmon was the effect of the road building along the Little Sacramento and the mouth of the Pitt that that year it was with great difficulty and only by very hard work that we

succeeded in getting barely 1,000,000 salmon eggs, and the next year Prof. Baird, in disgust at what he considered the unpardonable indifference of the Californians, discontinued taking salmon eggs at this station. Since that time sawmills of immense capacity have been erected at the head of the Little Sacramento and the McCloud, and have done very effective work in increasing the now alarming scarcity of the spawning salmon of the Sacramento.

I think these instances are sufficient to show that what the friends of the salmon have to fear more than overfishing is the growth or development of the country always attendant upon an increasing population, but the fatal consequences of which to the salmon it is impossible to avoid. Nothing can stop the growth and development of the country, which are fatal to the salmon. For instance, there was no power in the world that could have prevented the mining on the Feather, the Yuba, the American Fork, or the other spawning streams of the salmon; nothing could have stopped the building of the railroad up the Little Sacramento or the erection of the sawmills on the upper McCloud. They came along naturally and inevitably in the march of events, and they could not be withstood; and nothing was left for the salmon but to suffer the consequences and disappear as by a decree of fate.

Now actual fishing in the salmon streams can be regulated by law and rendered comparatively harmless, but the country will continue to grow more and more populous, and the fatal march of civilization will proceed as irresistibly as ever. That can not be held back, and unsafe as the salmon are now in our Atlantic and Pacific coast rivers, they will become more and more unsafe every year; all of which goes to show that there is no safe place for the salmon within the limits of the United States proper.

This leaves us only Alaska. Now, how is it with the salmon streams of Alaska? Not even there are the salmon safe. Countless myriads of salmon formerly filled all the rivers and streams of the long Alaskan coast, and they were nearly 2,000 miles from the destroying hand of civilized man, but they were not safe even on those distant shores. The ubiquitous canneryman found them, and he already has his grip on the best and most fruitful of the Alaskan rivers. The pressure of the world's demand on the world's supply of canned salmon renders it necessary for the salmon-canner to occupy more distant and less fruitful fields every year, and it is only a question of time when all the Alaskan salmon streams are given over to the canneries, and when that time comes no one will claim, I think, that the salmon are safe in Alaska.

One or two illustrations are sufficient. The Karluk River, on Kadiak Island, is probably the most wonderful salmon river in the world. On August 2, 1889, the cannery nets caught on Karluk Beach, at the mouth of the river, 153,000 salmon by actual count. A short time after, the writer went up the Karluk River in a bidarka—the skin boat of the natives—expecting to see myriads of salmon spawning and thousands on their journey to the spawning-grounds, but instead of the wonderful sight we anticipated, our whole party, I think, saw less than a dozen in the river till we reached the lower spawning-grounds, and then, to our astonishment, we saw only a few scattering fish spawning, such as one might expect to see in the most commonplace salmon river in the world; 153,000 salmon caught in one day at the mouth of the river, and none to speak of going up the river to reproduce their species. Every one can draw his own inference. The fact is significant enough.

On another river, a large one, the Nushagak, where vast numbers of salmon were taken at the mouth one summer for canning, we were told that the succeeding winter the natives living up the river were brought to the verge of starvation because the salmon which they had always depended on for their winter's food were so scarce. Of the thousands and thousands of salmon that usually ascend the river to spawn, not enough spawners escaped the nets at the mouth to keep the natives on the upper waters from starving. This fact speaks for itself also.

So much for the safety of salmon in Alaska in general, but it would yet seem that on the uninhabitable shores of the Arctic Ocean the salmon might find a place of refuge; but not even there can they stay unmolested, for parties were planning three years ago, the writer was told, to establish canneries on the affluents of the frigid and forbidding Arctic. So we see that our salmon are not safe even in Alaska, their last refuge, and if not there, they are not safe anywhere within the limits of our broad land.

But now the question comes up, "Will not protective laws and artificial breeding make the salmon secure enough?" My answer is that good laws and artificial breeding will do a good deal toward it, but not enough. Good laws can prevent overfishing, but no laws can arrest the encroachments on the salmon rivers of increasing populations and their consequent fatal results to the salmon. No laws could possibly have been enacted which for instance would have stopped the manufacturing enterprises

on the Connecticut, or the vast water traffic of the great metropolis at the mouth of the Hudson, which doubtless drove the salmon out of these rivers. Protective laws may regulate the salmon fishing of the Sacramento, but no laws can stop the mining, the logging, and the railroad building that are destroying the spawning-grounds of the tributaries of the Sacramento. It is not in the power of law enactments to save the salmon from all their dangers.

Artificial breeding can do a great deal, and has done a great deal, but it can not be relied upon for a certainty. In the first place, it is very uncertain where one can find a suitable place for hatching salmon. The writer traveled over 4,000 miles up and down the Columbia and its tributaries, from the Continental Divide to the Pacific coast, looking for a good place for salmon hatching, first in 1877 for the Oregon and Washington cannery men, and afterward in 1883 for the U. S. Fish Commission, and found only two places in that great stretch of country which were suitable; one on the Clackamas River, where the writer built a hatching station, and the other on the Little Spokane, a few miles from Spokane Falls, which is still unoccupied.

There is in all the great State of California but one stream suitable for salmon hatching on a large scale, and on this stream, strange as it seems, there is but one spot that meets all the requirements of the case, and that is the place that the writer selected and built upon on the McCloud River in 1872, and named Baird, in honor of the distinguished Commissioner under whose direction the work was done. Allow me to add by way of confirmation that subsequently the State fish commissioners of California, after hunting all over the State for another place for hatching salmon, have given it up, and now get their supply of salmon eggs from the Government station at Baird.

The above instances illustrate the difficulty of finding suitable places for hatching salmon on a large scale; and not only is it not easy to find such places, but they can not be relied on to a certainty when they are found, for they are always in danger from logging, mining, railroad building, lumber manufacturing, and other causes, which yearly become more imminent and dangerous as the country gets settled up and the population increases, and which threaten at any time to destroy their efficiency.

We must come to the conclusion, then, that even with the help and support of protective laws and artificial breeding, our salmon, like the buffalo of thirty years ago, are not safe. The destroying agencies of advancing civilization drove the buffalo to the last ditch, so to speak, and then the last survivors, or almost the last, were slain. They were obliged from sheer necessity to come to feed where from all directions the hand of man was raised against them. Whether they turned to the north or to the south, to the east or to the west, they went to their certain death, and in an incredibly short space of time they practically disappeared.

The story of our salmon is analogous. They are obliged to come inland to breed. They are compelled from sheer necessity to come up the rivers into the very midst of their human enemies. They can not stay in the ocean like other fishes of the sea, where they are safe from the hand of man, but they must necessarily come, one might say, into his very grasp, and, like the buffalo, whether they turn to the north, south, east, or west they go into the very jaws of death; for what hope is there for a salmon to escape after he has entered a river, if man chooses to employ his most effective agencies for his capture? There is none. The salmon is doomed. There is no altar of refuge for the salmon in this country any more than there was for the buffalo.

Ought not something to be done then? Ought this state of things to continue? The salmon of the United States are one of our most valuable possessions. As a matter of ordinary prudence, ought not the country to have some place, if it is possible, where the salmon can come and go in safety? If a stock-raiser saw that his cattle were daily diminishing because they had no spot where they were safe from beasts of prey, what kind of man should we think he was if he did not very soon fix a place where they would be safe? We should, to draw it mildly, think he was very improvident and negligent. Is it any less improvident and negligent for this country not to provide a place for its rapidly diminishing salmon where they will be safe? It seems to the writer that not a day ought to be lost, but that if it is possible to provide a place where our salmon can resort unharmed and remain safely their allotted time, it should be given them without hesitation. If there is such an asylum of refuge within our borders, by all means secure it for the salmon and let the salmon have it for an eternal heritage.

Is there such a place within the limits and jurisdiction of the United States? The writer can say from personal knowledge that there is one place at least. Most fortunately for us Americans there is in our Alaskan possessions just such a place as is wanted—probably more than one—and so exceptionally fortunate is America in this respect that it is not likely that this side of the frozen and uninhabit-

able shores of the Arctic it can be duplicated many times in the possessions of all the nations of the earth combined, which significant circumstance, allow me to add in passing, goes to show how near the world has reached the extreme limit of its salmon supply.

The locality which the writer has in mind is an island in the North Pacific about 750 miles nearly due west of Sitka. Its name is Afōgnak, and it is the northernmost of the two largest islands of the group called the Kadiak Islands. It lies just north of latitude 58° and between 152° and 153° west longitude. It is a small island, probably not over 50 miles across at its widest part, but there are several streams flowing from various points of the island to the surrounding ocean that at the proper season contain salmon innumerable. It is no exaggeration to say that salmon swarm up these streams in countless myriads. When the writer was on the island in 1889 the salmon were so thick in the streams that it was absolutely necessary in fording them to kick the salmon out of the way to avoid stumbling over them. I know that this story is an old salmon chestnut, but it illustrates as well as anything the wonderful abundance of salmon in the Afōgnak streams; and it can be easily believed when it is remembered that about a month earlier 153,000 salmon were caught in one day at the mouth of the Karluk, which is a river only 60 feet wide where it empties into the ocean. But there is no need of consuming time in proving the abundance of salmon at Afōgnak Island. It is a matter of record. The salmon are there in as great numbers as could be wished. All the varieties also which inhabit the Pacific Ocean come to Afōgnak. The list is as follows; it is a royal catalogue:

1. The red salmon, the "blueback" of the Columbia (*Oncorhynchus nerka*).
2. The king salmon, the "quinnat" or "spring salmon" of the Columbia (*O. chouicha*).
3. The silver salmon, the "silversides" of the Columbia (*Oncorhynchus kisutch*).
4. The humpback salmon (*Oncorhynchus gorbuscha*).
5. The dog salmon (*Oncorhynchus keta*).
6. The steelhead, the "square-tailed trout" of the tributaries of the Columbia (*Salmo gairdneri*).
7. The Dolly Varden (*Salvelinus malma*).

It is easy to see what a paradise for salmon this island is, and what a magnificent place of safety it would be if it were set aside for a national park where the salmon could always hereafter be unmolested. But the abundance and variety of its salmon are not the only recommendations that Afōgnak Island has for a national park. It has several others, which may be enumerated as follows:

1. The island is inhabitable all the year round, with a comparatively even temperature. Although so far north, the winter's cold is not excessive, probably not equaling that of parts of New England. It is cooler than New England in summer, it is true, but there is much less variation of temperature between summer and winter.

2. The rivers of Afōgnak still exist in all their original purity and fruitfulness. No overfishing has left them barren. No mills have polluted their primeval purity. No railroads have frightened the salmon away from them. No mining has disturbed their native spawning-grounds. As salmon rivers they are still in their original glory. To quote a not inappropriate line of Byron, "Such as Creation's dawn beheld" them, they are rolling now. Consequently, nothing need be done nor any expense incurred in putting the rivers in order for asylums of refuge for the salmon.

3. No complications now exist or can come up in future in regard to land titles in the island. The United States Government owns the land already, like the rest of Alaska, by direct purchase from Russia, and has never parted with any of its exclusive rights of ownership. No State or Territory or company or individual owns an acre of it. Consequently the United States Government can set aside the island for any purpose whatever, without interfering with any prior rights or titles, or incurring any risk of litigation.* Alaska is already one great reservation.

4. The island will probably never be wanted for anything else. The summer season is so short that no crops can be raised there, and it is not likely that for many generations, if ever, the land will be wanted by permanent settlers, and it is now inhabited only by a few Aleuts and half-breed families who would not be interfered with. There would be no injustice done to individuals by making a reservation of the island.

5. Last but not least, artificial hatching can be instituted there at any time, if it is ever thought best, and on a vast scale if desired; and unlimited numbers of the eggs of the various kinds of salmon noted above can be obtained for distribution and sent to all other parts of the country where they may be needed.

* There are two canneries operating in the southern part of the island, but there would probably not be great difficulty in making satisfactory arrangements with them.

The above considerations seem to indicate that Afognak Island possesses all the qualifications required for a place of safety for our Pacific Ocean salmon without presenting any objections to its being reserved by the Federal Government for salmon, or in other words converted into a national salmon park.

The writer, however, would not urge the claims of Afognak or any other place to this distinction as against those of any locality that may be found to be better fitted for it. This island has been brought forward merely as showing that one place at least is known that would answer the purposes of a salmon park. There are doubtless others in our Alaskan possessions. There are possibly better ones. If a better place can be found, let us take it. If not, let us take Afognak Island; but at all events let some place be selected and set aside by the authority of the National Government. If not Afognak Island, let it be some other place. Provide some refuge for the salmon, and provide it quickly, before complications arise which may make it impracticable, or at least very difficult. Now is the time. Delays are dangerous. Some unforeseen difficulties may come up which we do not dream of now, any more than we did a few years ago of logging on the Clackamas or railroad building on the upper Sacramento.

If we procrastinate and put off our rescuing mission too long, it may be too late to do any good. After the rivers are ruined and the salmon are gone they can not be reclaimed. Exaggerated as the statement seems, it is nevertheless true that all the power of the United States can not restore the salmon to the rivers after the work of destruction has been completed. The familiar nursery rhyme about the egg applies here with peculiar fitness:

"Humpty Dumpty sat on a wall,
Humpty Dumpty had a great fall.
All the king's horses and all the king's men
Could not set Humpty as before."

That is the whole thing, so to speak, in an eggshell. After the salmon rivers are ruined all the king's horses and all the king's men, that is to say, all the power of the Government "can not set them as before."

Let us act then at once and try to do something for the salmon before it is too late. Dangerous complications may come suddenly upon us which we can not foresee. How little we foresaw the danger to the buffalo and the fur seals. How suddenly the disastrous results came. Even if not impracticable, it may cost large sums of money to do hereafter what may be done now for nothing. No expense need be incurred at present. All that is required is to have Afognak Island or some other suitable place set aside by national authority, as Gen. Grant set aside the McCloud River Reservation during his administration, and it can be left to future events to decide whether it is expedient to expend any money on the reservation, a subject that can be safely left, we all know, in the hands of our efficient Commissioner of Fish and Fisheries. There seems to be no impropriety in the United States having a national salmon park, but on the contrary it appears eminently proper that a great natural salmon country like ours should have set apart some safe repository and fruitful breeding-grounds for this noble fish.

Consider for a moment what the salmon has done for us, and then think how mercilessly we have treated him. Our salmon has been to us a source of national revenue, enjoyment, and pride, and what return have we meted out to him? He has been hunted pitilessly with hooks and spears, with all kinds of nets and pounds, with wheels and guns and dynamite, and there is not a cubic foot of water in the whole country where he can rest in safety. The moment he comes in from the ocean he meets the gill nets and the pounds at the mouth of the river, the sweep seines further up, the hook everywhere, and at last on his breeding-grounds, which at least ought to be sacred to him, he encounters the pitchforks of the white man and the spears of the Indian.

Let us now, at the eleventh hour, take pity on our long-persecuted salmon and do him the poor and tardy justice of giving him, in our broad land that he has done so much for, one place where he can come and go unmolested and where he can rest in safety.

Allow me to add in closing that it seems to me highly appropriate that this society, which represents with such intelligence and ability all the fishing interests of every kind of this country, should take the initiative in a matter in which those interests are so closely concerned. The writer trusts that it will, and ventures to predict that, if its efforts in that direction should happily be rewarded by the creation of a national salmon park, it would become an enduring monument to the usefulness of the society that would last as long as the nation lasts.—LIVINGSTON STONE.

Absolute prohibition of the capture of salmon by the use of any kind of nets or traps within 100 yards of the mouths of the rivers would assure that some proportion of each run of salmon would succeed in entering the streams and reaching the spawning-grounds.

The prohibition of the use of more than one seine in the same berth would prevent that actual and effective obstruction of the approaches to the rivers which is now accomplished by the use of seines in pairs sweeping the same area, and succeeding each other so continuously as to capture every fish coming within the seine berth.

The above requirements, reasonably and uniformly enforced, would probably be sufficient to maintain regular conditions of production and render permanent this great food resource. Should they be supplemented by recourse to artificial propagation on an adequate scale, it will be possible not only to maintain the present supply, but probably greatly to increase the annual production. The enforcement of the regulations and requirements, above indicated, would, however, demand constant and minute supervision and the employment of a large personnel and a difficult administration.

It is believed that better results and more satisfactory administration could be accomplished by limiting the catch in each stream to its actual productive capacity under existing conditions, and by leasing the privileges of taking the salmon to the highest bidders. The lessees of any river would see that there was no trespassing upon privileges for which they paid. The limitation of the catch being kept safely within the natural productive capacity of the stream, greater care would be exercised by the canners, the quality of the products would be improved, and stability of prices assured by reason of the fact that the total production would be approximately known in advance of the season.

The number of cases packed would be a matter of easy and accurate ascertainment by the Government agent charged with that duty. Should the funds obtained from the lessees be applied first to the administration of the regulations of the fishery, and the balance devoted to systematic fish-culture, it is probable that the revenues from these fisheries will not only suffice for their rational management, but will permit and provide for such extensive fish-cultural operations as will not only maintain present conditions and production, but also greatly increase the annual output.

Very respectfully,

MARSHALL MCDONALD,
Commissioner.

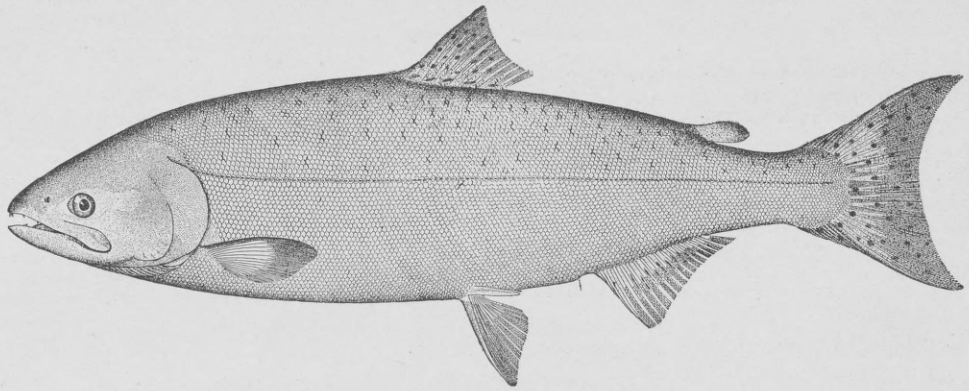


FIG. 1. THE KING SALMON (*Oncorhynchus chouicha*).

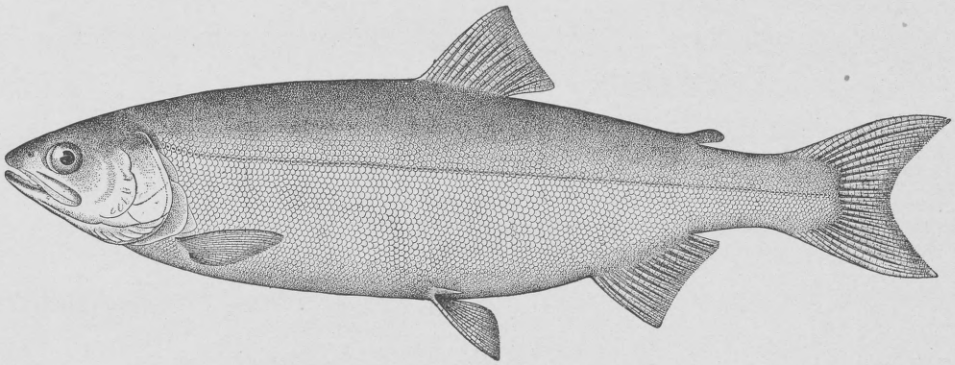


FIG. 2. THE RED SALMON (*Oncorhynchus nerka*). Sea-run.

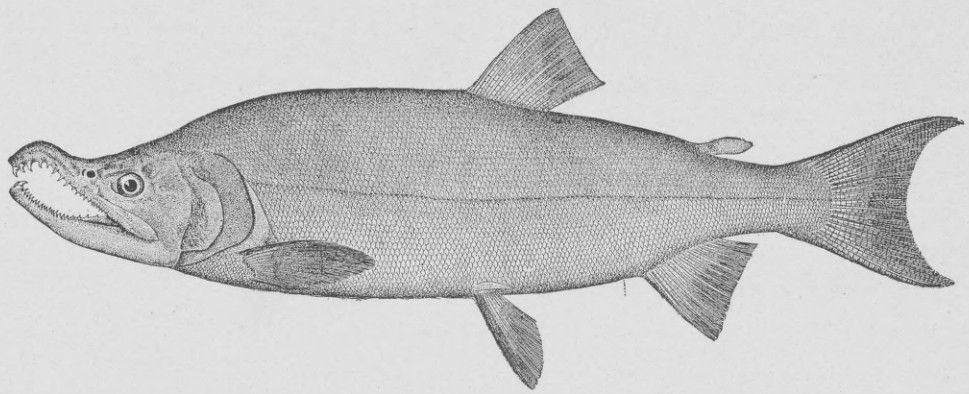


FIG. 3. THE RED SALMON (*Oncorhynchus nerka*). Breeding male.

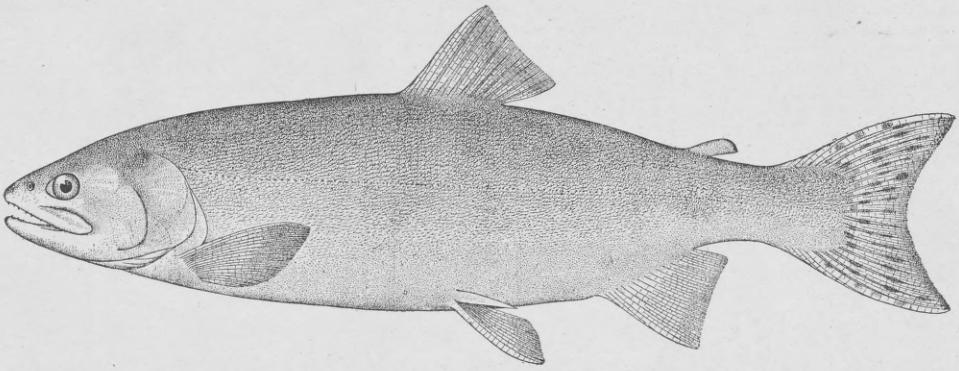


FIG. 1. THE HUMPBACK SALMON (*Oncorhynchus gorbuscha*). Sea-run.

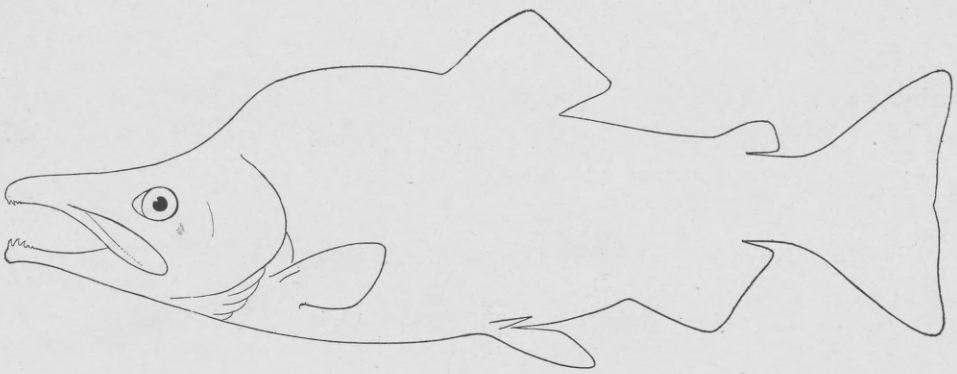


FIG. 2. THE HUMPBACK SALMON (*Oncorhynchus gorbuscha*). Breeding male.

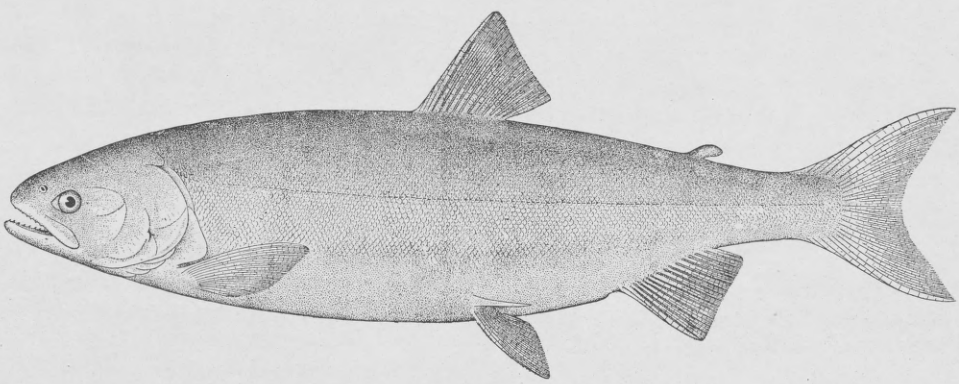


FIG. 3. THE DOG SALMON (*Oncorhynchus keta*).

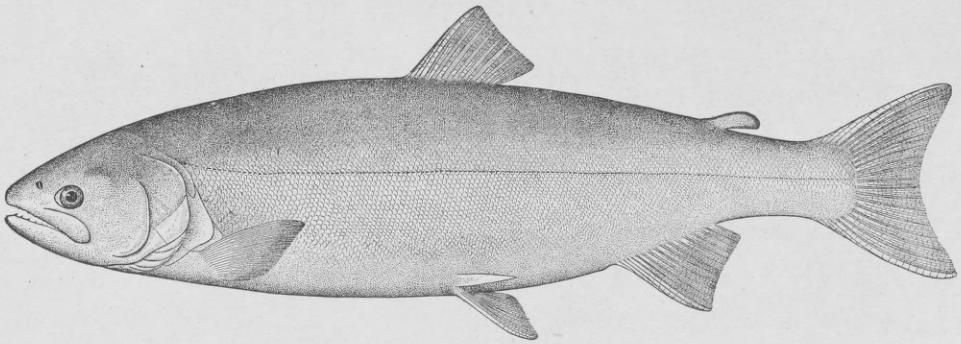


FIG. 1. THE SILVER SALMON (*Oncorhynchus kisutch*).

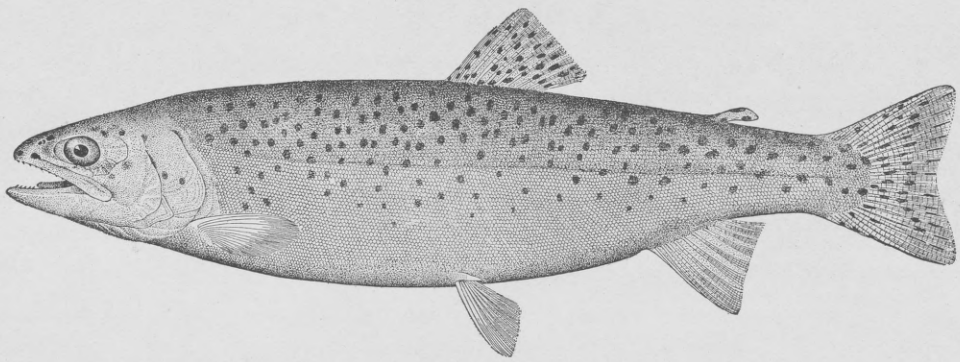


FIG. 2. THE RED-THROATED TROUT (*Salmo mykiss*). Adult.

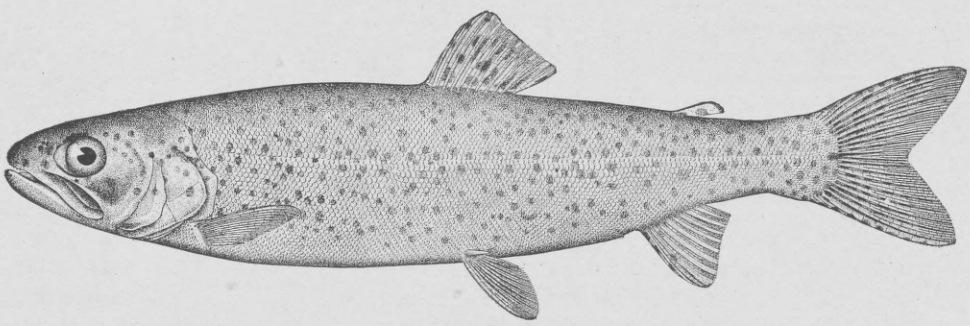


FIG. 3. THE RED-THROATED TROUT (*Salmo mykiss*). Young.

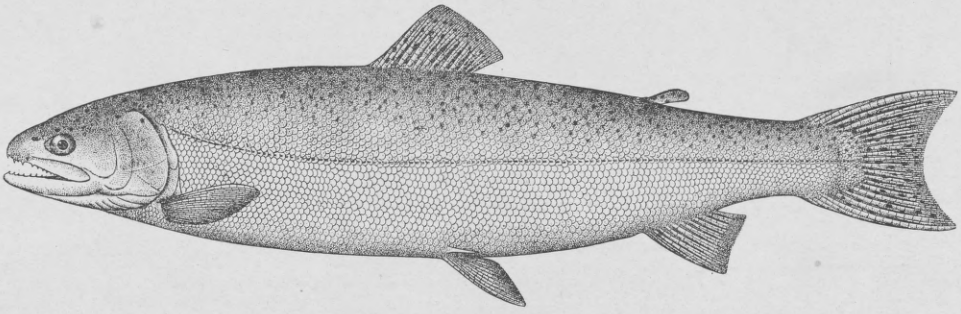


FIG. 1. THE STEELHEAD (*Salmo gairdneri*). Adult.

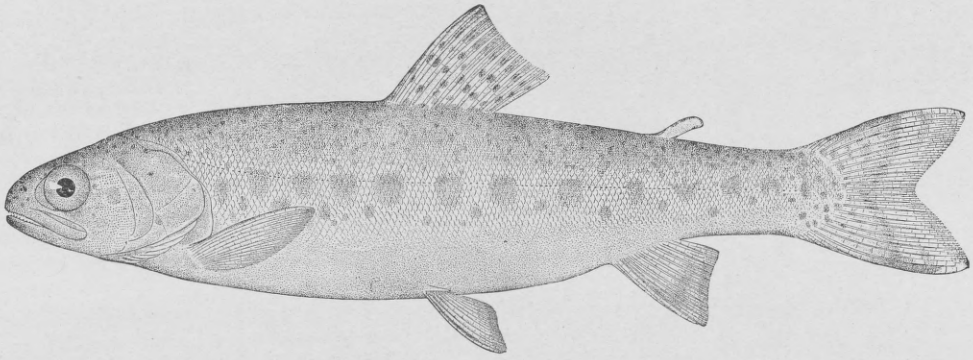


FIG. 2. THE RAINBOW TROUT (*Salmo irideus*). Young.

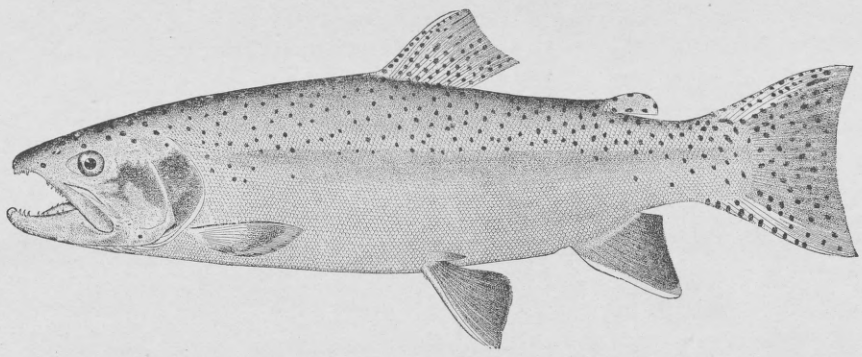


FIG. 3. THE RAINBOW TROUT (*Salmo irideus*). Adult male.

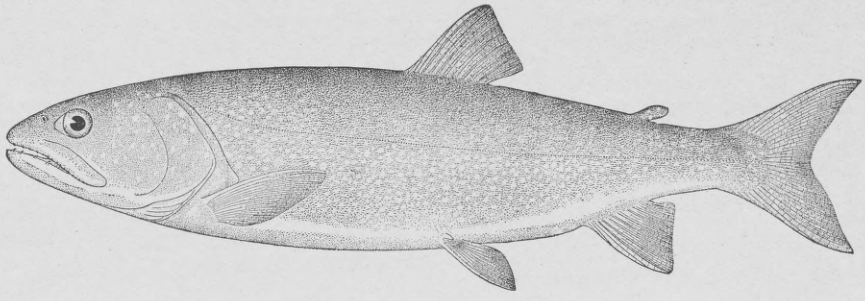


FIG. 1. THE LAKE TROUT (*Salvelinus namaycush*).

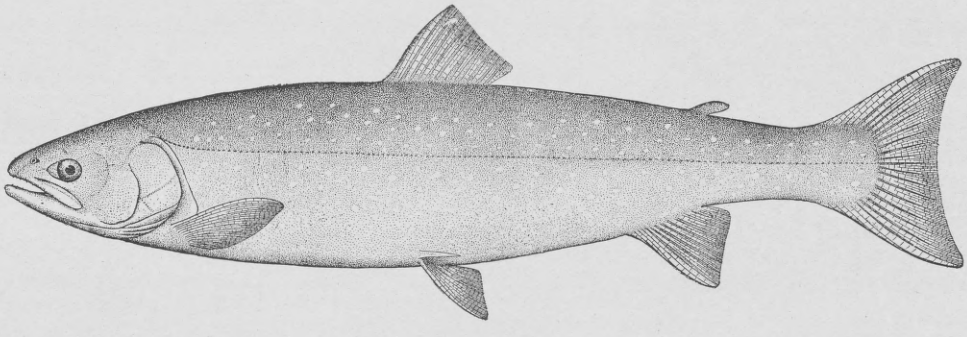


FIG. 2. THE DOLLY VARDEN TROUT (*Salvelinus malma*).

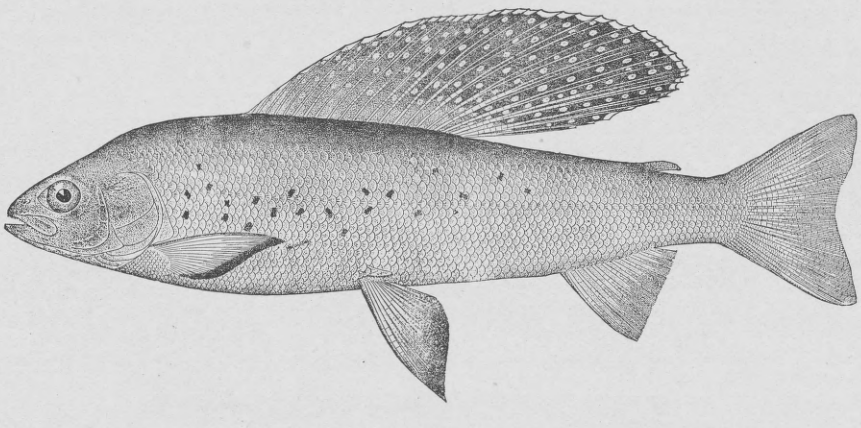


FIG. 3. THE ALASKA GRAYLING (*Thymallus signifer*).

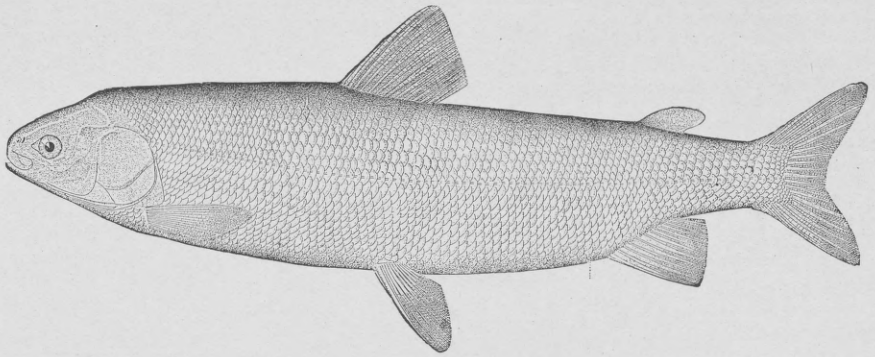


FIG. 1. THE BROAD WHITEFISH (*Coregonus richardsoni*).

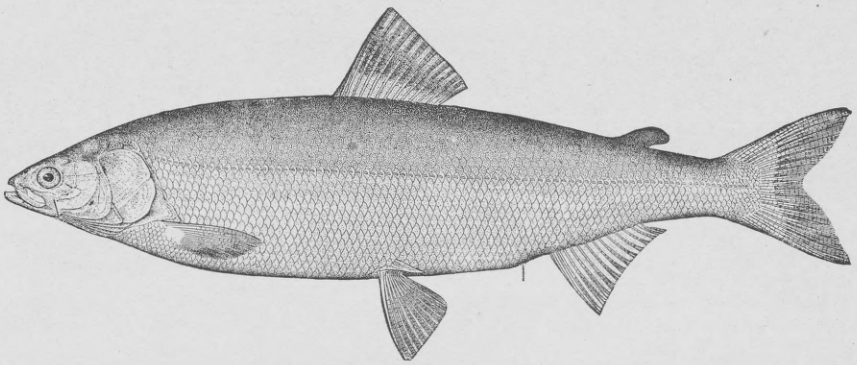


FIG. 2. THE LAURETTA WHITEFISH (*Coregonus laurettæ*).

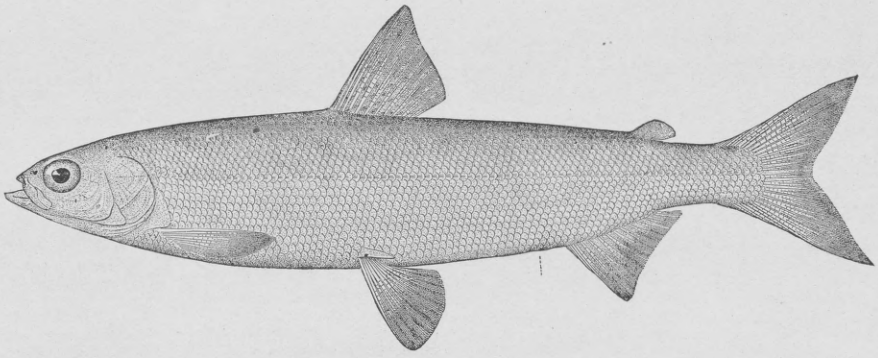


FIG. 3. THE SMALL WHITEFISH (*Coregonus pusillus*).

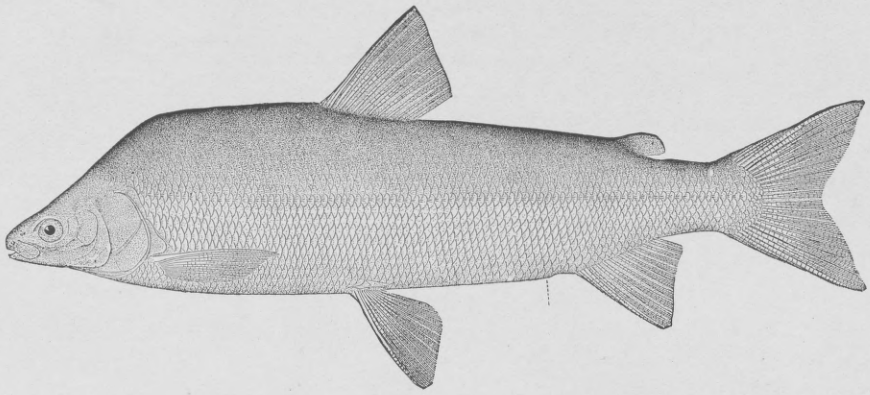


FIG. 1. NELSON'S WHITEFISH (*Coregonus nelsoni*).

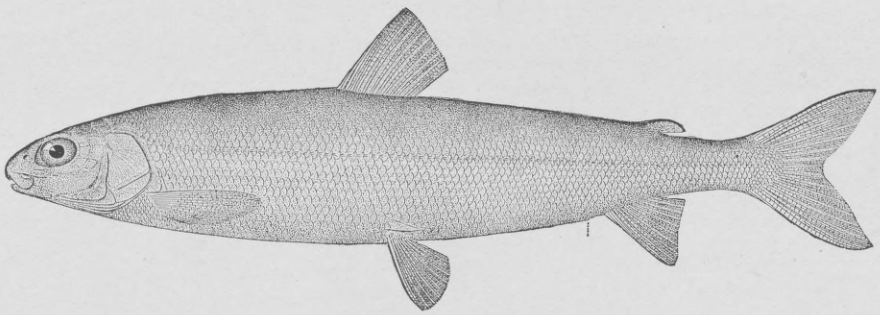


FIG. 2. THE ROUND WHITEFISH (*Coregonus quadrilateralis*).

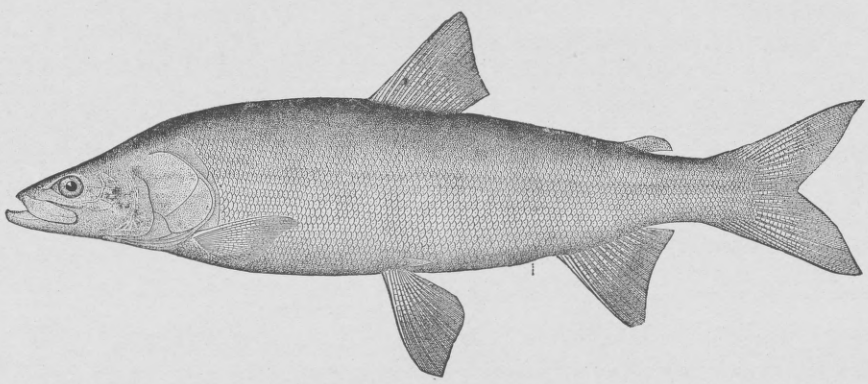


FIG. 3. THE INCONNU (*Stenodus mackenzii*).

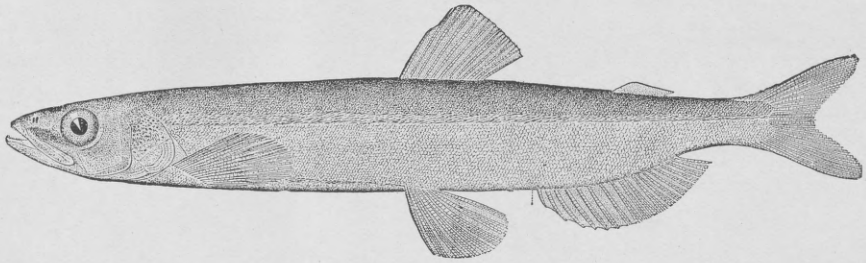


FIG. 1. THE CAPELIN (*Mallotus villosus*).

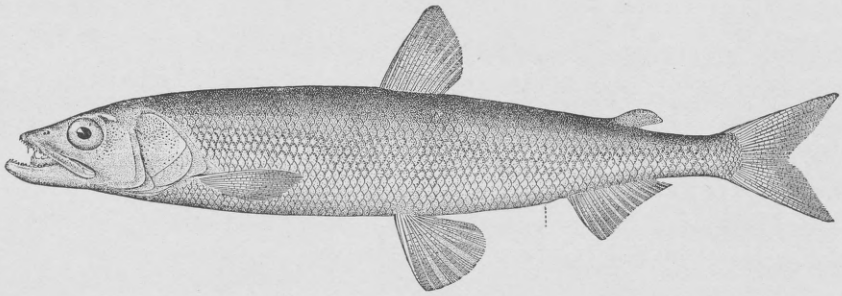


FIG. 2. THE SMELT (*Osmerus dentex*).

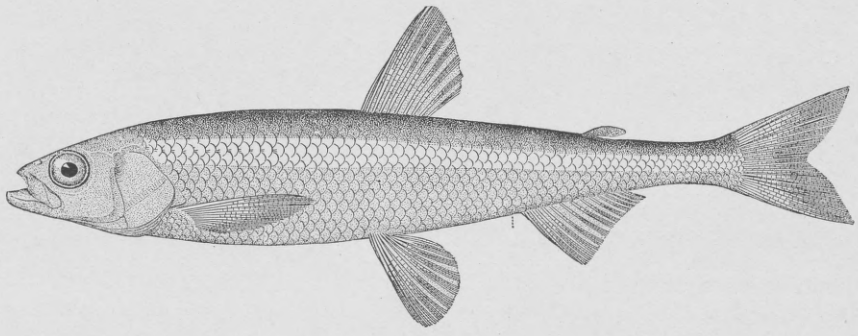


FIG. 3. THE SURF SMELT (*Hypomesus olidus*).

LIFE HISTORY OF THE SALMON.

BY TARLETON H. BEAN, M. D.,
Ichthyologist, U. S. Fish Commission.

The greatest wealth of Alaska is represented by its fishes, and among these by far the most important are the members of the salmon family and other closely related forms, such as the whitefishes, grayling, smelt, and capelin. The salmon alone represent an annual value for canning purposes of about $3,000,000, derived almost entirely from three species. The undeveloped resources which may be obtained from the salmon-like fishes have undoubtedly equal importance with the material now utilized.

In the distribution of the *Salmonidæ* Alaska received a generous share. Seventeen of the known species, or about one-sixth of the entire number, occur in its waters. Lying entirely within the area in which the family is indigenous, plentifully supplied with long water courses, rapid snow-fed streams, and cool, deep lakes glistening in mountain valleys, over beds of clean gravel and bowlders intermingled with sheltering water plants, free from obstructions to the movements of the migratory species, its invitation to the salmon to come in and possess the waters and multiply therein was readily accepted.

The largest salmon of the world are credited to this Territory, and there is no doubt that in Cook Inlet king salmon which weigh over 100 pounds are occasionally taken, but this is far above the average weight of the species. The most abundant salmon in Alaska are the red salmon and the little humpback, and it is these species which figure in the wonderful tales concerning rivers which contain more fish than water, tales which sound incredible to those who have never visited Alaska, but which in many cases are strictly true.

The salmon have been traced as far north as Hotham Inlet, and one species is found well to the eastward of Point Barrow. It is quite probable that this species, the little humpback, extends its migration to the Mackenzie.

The rivers and lakes of Alaska contain five species of whitefish, the largest one (*Coregonus richardsoni*, Pl. VII, Fig. 1), sometimes reaching a weight of 30 pounds. For many years this was believed to be identical with the common whitefish of our Great Lakes fisheries, but it differs from this in many particulars. The species was known to the Russians as the "*muksun*." In the report of the Commissioner of Agriculture for 1870, page 386, Dall refers to it as the "broad whitefish," which, he says, "is usually very fat and very good eating. It abounds in both winter and summer, spawning in September in the small rivers falling into the Yukon." This is the species which Milner named *Coregonus kennicotti*, in honor of Robert Kennicott. Capt. E. P. Herendeen, of the Signal Service expedition to Point Barrow, found this whitefish in Meade River in October, 1882. This stream is a tributary of the Arctic Ocean to the eastward of Point Barrow. The southern limit of this species is not known, but it

probably extends at least as far south as the Bristol Bay region. The great size and fine quality of its flesh make it one of the most important food-fishes of the Territory.

The round whitefish, shad-waiter, or chivey of New England (*Coregonus quadrilateralis*, Pl. VIII, Fig. 2), extends through the upper Great Lakes region, the Northwest Territory, and other parts of British Columbia, into Alaska. Specimens have been obtained as far north as the Kuwuk, or Putnam River, a tributary of Hotham Inlet. This fish does not reach a large size, seldom exceeding 2 pounds in weight, but it is very abundant and palatable, and consequently is an important food resource.

A third species, called *Coregonus laurettæ* (Pl. VII, Fig. 2), abounds from the Bristol Bay region to Point Barrow. It is a little larger than the round whitefish, but seldom exceeds 3 pounds in weight. It resembles the so-called lake herring (*C. artedi*) of the Great Lakes, and is an excellent food species.

The fourth species is known as the humpback whitefish, and was named in honor of Mr. E. W. Nelson (*Coregonus nelsoni*, Pl. VIII, Fig. 1). It bears considerable resemblance to one of the Siberian species, from which, however, it can be readily distinguished. As food for man it has little value, but enormous quantities are consumed by the dogs. This species is found in all parts of the Territory from the peninsula of Alaska northward. Breeding males have a very large hump developed on the nape, which is compressed to a thin edge.

The fifth species of whitefish (*Coregonus pusillus*, Pl. VII, Fig. 3) is the smallest of all, and has the reputation of being more bony than any of the others. It is used chiefly by native traveling parties and as food for dogs. This fish seldom exceeds a foot in length and its average weight is less than 1 pound, but it extends over a large part of Alaska, and is represented by a vast number of individuals. As far as our information goes, it is found in all parts of the Territory except the southeastern portion.

The largest and handsomest fish of this category is the so-called Mackenzie River salmon or *inconnu* (Pl. VIII, Fig. 3), which is known to the Russian-speaking people as the *nelma*. This species is intermediate between the whitefish and the salmon. It has a strongly projecting lower jaw, on account of which the additional name of shovel-jawed whitefish has been applied to it. This beautiful species attains to a length of 5 feet, and individuals weighing 50 pounds are recorded. It occurs in the rivers during the greater part of the year, is in the finest condition in the early summer, and is "full of spawn from September to January, when it disappears." The species is known to occur from the Kuskoquim to the Kuwuk. The largest individuals are recorded from the Yukon. It is found also in the Mackenzie. A closely related species is found in the Volga and other rivers of Russia, and is attributed also to the Obi, Lena, and Colima, which flow into the Arctic Ocean.

The grayling (*Thymallus signifer*, Pl. VI, Fig. 3) is a very common fish in Alaska, especially in the northern portion of the Territory, and it is one of the most attractive of all the Alaskan fishes. At one time the grayling had the reputation of being the only fish in the fresh waters of Alaska that could be caught with hook and line. It is known also as the "blanket fish," and occurs southward at least to the Nushagak region, where McKay found it "very abundant in small rivers and lakes." He speaks of it as "a good food-fish, much sought after by the natives in the fall, along with the whitefish and the great smelt." The high and beautifully colored dorsal fin of this species, the rich purple luster of the sides, and the jet black spots not far behind the head, make it one of the most conspicuous and beautiful species of the fresh waters.

The red-spotted brook trout of California, also known as the dolly varden (*Salvelinus malma*, Pl. VI, Fig. 2), is one of the best known and most abundant fishes of Alaska. In the sea-run condition, when its sides are uniform silvery and do not show the red spots, it is called the salmon trout, and, preserved in brine, forms a staple article of commerce. In Alaska the species increases in size northward. Individuals measuring 30 inches in length and weighing 8 or 10 pounds are frequently obtained. Natives of northern Alaska make waterproof clothing from the skin of this trout. The dolly varden abounds in all parts of the Territory, even in the Aleutian Islands and in the extreme northern limits. It is known to occur also in the Mackenzie and in the tributaries of the Saskatchewan—this basin apparently representing its eastern limit. The dolly varden takes the artificial fly very freely. On one of the islands of the Shumagin group several hundred individuals were so captured in one hour by a party from the United States steamer *Albatross* in 1889. Salmon eggs prove very effective also in taking this trout. The species is very destructive to the eggs of the various kinds of Pacific salmon. The young trout are destroyed in enormous numbers by gulls, terns, and other aquatic birds.

The lake trout (*Salvelinus namaycush*) or namaycush, tuladi, togue, lunge, etc., of the Great Lakes, New England, Labrador, Idaho, and British America (Pl. VI, Fig. 1), has been obtained in the Putnam or Kuwuk River, where it reaches a fine state of development. The southern limit of this species in Alaska is not known. This is the largest trout of North America and the most widely distributed. Its great size and the good quality of its flesh render it a very important species wherever it is known. This is one of the most variable of the North American trout in color, and much confusion has arisen from this circumstance. Individuals from the Kuwuk are similar in appearance to Labrador specimens, differing only in being slightly darker.

The rainbow trout of California (Pl. V, Figs. 2 and 3) appears to extend northward into southeastern Alaska, but is very little known in the Territory, and, consequently, is not of much importance there. One specimen of this trout was taken at Sitka by Capt. Beardslee in 1880, and is now preserved in the U. S. National Museum.

Gairdner's trout (Pl. V, Fig. 1), known also as the steelhead salmon, or "*soomgah*" of the Russians (*Salmo gairdneri*), reaches a very large size in Alaska, and extends northward at least to the Bristol Bay region. At Sitka this species is called "*Ah-shut*" by the Indians. We found gravid females at that place in June. This trout generally finishes its spawning before the arrival of the salmon, and is charged with the destruction of salmon eggs in large quantities. The species has not much importance commercially, although it reaches so large a size, attaining to the proportions of the Atlantic salmon, which it resembles in shape and color; but small quantities are dried by the natives and at the various fishing stations. This is the trout which is shipped from the Columbia River early in the spring to markets on the east coast, and sold in the fresh state under the trade name of "Kennebec salmon." Its distinction from the rainbow trout is difficult, and the two may prove to be identical. It will undoubtedly become an important species before many years. At the present time it is practically a waste product of the salmon fisheries of Alaska, and the same may be said of the dolly varden.

Clark's trout (Pl. IV, Figs. 2 and 3), recently styled the red-throat (*Salmo mykiss*), is very abundant in Alaska, extending northward at least to the Bristol Bay region. In the streams it can be readily taken with various baits, and greatly increases the

pleasures of angling. As a food-fish its quality is excellent, and it reaches a weight of 20 pounds or more. The species is black-spotted, the spots being larger and less numerous in Alaskan individuals than in most of the varieties which range southward in the Rocky Mountain region. The crimson streak around the throat is a conspicuous and characteristic color mark in all the many forms of this well-known trout.

Before passing to a review of the Pacific salmons we must recall the fact that Alaska has a bountiful supply of small fishes closely related to the larger *Salmonidæ*. A true smelt (Pl. IX, Fig. 2) and two kinds of surf smelt (one of these on Pl. IX, Fig. 3) are among the common fishes, the first being a food-fish of considerable value. The capelin (Pl. IX, Fig. 1), abounds on all parts of the coast, and is one of the most important food species of the cod and salmon. The eulachon, or candle-fish, is extremely abundant in southern Alaska, and is considered one of the finest pan-fishes known. A kind of fat is expressed from it which the Indians use as a substitute for butter, and which some pharmacists employ in the place of cod-liver oil. The species is so full of oil that when dried it will burn with a bright flame.

These smaller representatives of the salmon family have at present little commercial value, but they will figure eventually and very prominently among the resources of Alaska. In addition to their value as food for man, they play a very important part in attracting the larger commercial fishes of the salmon family to certain localities.

It may be well to state that the herring of Alaska is one of the finest species of the genus *Clupea*, and is universally known as one of the fishes upon which the salmon subsist. The herring visits all parts of the coast of Alaska, running up into the bays in schools, sometimes covering an area of many square miles. It comes into the shallow waters of the bays to deposit its eggs, reaching Cook Inlet for this purpose early in July, so that its appearance in force coincides with the height of the salmon runs. The capelin is also found early in the summer, and we know that salmon are very eager in their pursuit of this fish. The little sand launce, or lant, is also present in the bays in wriggling masses at the period when salmon abound.

The marine life of the Alaskan salmon is unknown from the time the young, in their newly-acquired silvery dress, leave the fresh-water nursery to become salt-water sailors, until they have ended their cruise, obtained their liberty, and come ashore, when, as in the case of so many other salt-water sailors, their serious trouble begins. Salmon remain in fresh water until the second or third spring of their existence, and not having a bountiful supply of food, they grow very slowly and seldom exceed 8 inches in length when they start seaward. In the ocean they feed on the capelin, the herring, and a small needle-shaped fish called the lant. They are reputed also to consume large quantities of pink-fleshed crustaceans, and to derive from them their attractive color. Opposed to this theory is the fact that many other sea fishes whose food consists almost entirely of such crustaceans are never pink-fleshed.

There is no such fishery at sea for any of the Pacific salmons as there is in the Baltic for the Atlantic salmon. After the great schools have broken up and the scattered fish come into the bays, some of the species can be caught on a herring-baited hook by trolling. The king and silver salmon are captured in this way.

As a rule the fish remain at sea until they are about ready to deposit their eggs, and then approach the coast in great masses. A few young males accompany the schools every year, and may or may not return to sea without entering the rivers. The adult fish come up from the sea at a certain time of the year, the king salmon arriving

first in the month of May in southern Alaska and about the 6th of June in Norton Sound. The dog salmon and the red salmon appear in June, the humpbacks in July, and the silver salmon in August. The length of their stay at the river mouths before ascending and the rate of ascent to the spawning-grounds depend upon the urgency of the breeding condition. In the long rivers the king salmon travels from 20 to 40 miles a day; this species and the red salmon are reported to be the greatest travelers. The silver and dog salmon, however, are recorded by Dr. Dall as traversing the Yukon at least 1,000 miles. As a rule, they frequent the smaller streams, and the little humpback runs into mere rivulets.

From the time the salmon enters fresh water it begins to deteriorate in flesh and undergoes remarkable changes in form and color. Arriving as a shapely fish, clad in shining silvery scales, and with its flesh pink or red, it plays around for a little while between salt water and fresh, and then begins its long fast and its wearisome journey. No food is taken, and there are shoals,rapids, and sometimes cataracts to surmount; but the salmon falters not, nor can it be prevented from accomplishing its mission by anything but death or an impassable barrier. Its body soon becomes thin and lacerated, and its fins are worn to shreds by contact with the sharp rocks. In the males a great hump is developed on the back behind the head, and the jaws are lengthened and distorted so that the mouth can not be closed. The wounded fish are soon attacked by the salmon fungus, and progress from bad to worse until they become unsightly. In the mean time the body colors will have varied from dark gray in the humpback, with the lower parts milky white, to a brilliant vermilion in the red salmon, contrasting beautifully with the rich olive-green of its head. The excessive mortality of salmon during the ascent of the streams and on the breeding-grounds has led to the belief that none of the spawning fish leave the fresh-water alive. There is a substantial basis for this view in the long rivers, and it is doubtless true that a journey of 500 miles or more is followed by the death of all the salmon concerned in it.

The nest is a very simple affair, or it may be wanting. The humpback struggles and crowds up a few rods from the sea, and deposits its eggs between crevices in the bowlders covering the bottom, or sometimes they are strewn in thin layers over a large area in shallow water without covering of any kind. The king salmon seeks the headwaters of streams, and excavates a nest in clear, shallow, gravelly rapids. The dog salmon spawns in small rivers and creeks.

The silver salmon does not usually ascend streams to a great distance, and I have seen it return to salt water alive, after spawning. The nest is made among gravel and stones, from which all dirt and slime have been removed. Both sexes take part in the building operation, and the male especially guards the nest. Turner states that the silver salmon use their snouts in collecting material for the nests, and he has seen them with the nose worn off completely.

The red salmon spawns around the shores of deep, cool lakes, and in their tributaries, preferring waters whose highest temperature rarely exceeds 55 degrees. The nest is a shallow, circular pile of stones, some of which are about as large as a man's hand and some of them smaller. The eggs are placed in crevices between the stones.

The enemies of the salmon are numerous. Small fish, called sculpins, or miller's thumbs, swarm in the nests, and eat large quantities of the eggs. Trout devour great numbers of eggs and young salmon. Gulls, terns, loons, and other birds gorge themselves with the tender fry. When the young approach the sea they must run a cruel

gauntlet of flounders, sculpins, and trout; and in the ocean a larger and greedier horde confronts them. There the adults are attacked by sharks, seals, and sea lions. Before they have fairly entered the rivers huge nets are hauling them to the shore almost every minute of the day, during six days in a week. When they return to their spawning-grounds, bears are waiting to snatch them from the water and devour them alive. The salmon, it appears, would have been better off had it never been born in fresh-water, where its dangers are cumulative and deadly.

The King Salmon (*Oncorhynchus chouicha*). Plate II, Fig. 1.

The largest and finest of the Alaskan salmon is the king, or chowichee, known also as the Takou, Columbia River, chinook, and quinnat. This valuable fish occurs in the large rivers as a rule, but it runs into some of the small streams also, notably the Karluk, and some of the rivers emptying into the eastern part of Cook Inlet. The Yukon and the Nushagak are the greatest king salmon rivers. The species is found less abundantly in the Ugashik, Kuskoquim, and Kvichuk. Its average weight is over 20 pounds, and individuals of 100 pounds or more are recorded. At St. Paul, Kadiak, in 1880, Mr. B. G. McIntyre stated he had weighed one which registered 87½ pounds without its viscera; he believed the entire fish would have weighed 100 pounds.

The flesh of the king salmon is paler in color than that of the red salmon, but superior to all others in flavor. The salted bellies are considered a great delicacy. The principal uses of this fish are as fresh fish and for canning purposes. In Alaska it has not yet acquired the importance belonging to it on the Columbia River, chiefly because of the distance from San Francisco to the Alaskan king salmon rivers and the difficulties of fishing in those waters.

This species is the first to arrive on the shores in the spring. It makes its appearance in southern Alaska in May, and Mr. E. W. Nelson found it in Norton Sound, the northern limit of its known migration, early in June. The time of its coming into Norton Sound corresponds with the breaking up and disappearance of the ice. Mr. Nelson observed that "the largest of these salmon run during the few days just preceding and following the breaking up of the ice, and thence on until the end of the season they decrease gradually in size and quality." In the Yukon the season lasts only about a month. Capt. L. P. Larsen states that the king salmon is the first to appear in the Nushagak; here the run is short, scarcely continuing into August. At the Karluk they arrive late in May. Very few were seined there during August. On the 4th of August, 1889, a fine male of about 35 pounds, with the spermaries little developed, was seined on the beach. In its stomach I found forty-five capelin. Mr. Charles Hirsch states that the species is only an occasional visitor at Karluk.

The king salmon continues to enter some of the rivers for the purpose of spawning until August. The height of the season, however, is reached by the middle of July in most localities. This fish travels up the rivers farther than any other species except the red salmon. In the Yukon it ascends far above Fort Yukon, more than 1,500 miles from the mouth of the river. Dr. George M. Dawson records its occurrence in the Lewes River as far as the lower end of Lake Marsh, where it was found in considerable numbers early in September. According to Indian authority it pushes on almost to the headwaters of the tributaries to the Lewes on the east side.

The king salmon does not ascend rivers rapidly unless the spawning period is close at hand. It generally plays around for a few days, or even a couple of weeks, near the river limit of tide-water. After entering the fresh water to begin its journey

to the headwaters of the stream it moves rapidly until it finds suitable gravelly bottom in clear water. No food is taken in fresh water. When a barrier to its ascent is met I am told that the fish charges at it repeatedly and persistently without regard to the consequences to itself. The nest-building habits have been so often described that it is unnecessary to repeat them here. The spawning takes place, as before remarked, near the headwaters of streams in clear, shallow rapids. As far as we can learn, only those fish that ascend the streams short distances return to the ocean after spawning, and September is the month in which the spent fish go down to the sea. Mr. Turner mentions a female weighing 38 pounds, which had spawned and returned to the sea and was caught at Unalaska, September 25, 1878; it was in fine condition for eating.

There is no reason why the king salmon should not return down the Karluk, as the distance is very short and the fatigue of the journey upstream is very slight. There is ample testimony of a conclusive nature to the effect that after a king salmon ascends 500 miles from the sea it never returns to it alive.

Mr. Charles Hirsch says that the Karluk natives watch for the king salmon in May, and set up a great shout as soon as they discover it. Like the other species, it can be seen about 1½ miles off shore in great schools, but before coming nearer the schools break up. There is no salt-water fishery for this salmon in Alaska, except along the beaches.

No falling off has been observed in the supply of the king salmon; in fact the number used is very small in comparison with that of the red salmon.

The Dog Salmon (*Oncorhynchus keta*). Plate III, Fig. 3.

This is one of the least important of the Alaskan salmon to Americans, but one of the most valuable to the natives. Its flesh is comparatively pale, and it deteriorates so rapidly in fresh water as to prove very unattractive to white people. Mr. Daniel F. Bradford states that after remaining in fresh water twenty-four hours the fish turn black, become covered with slime, and are unfit for food. The jaws become enlarged and distorted, and the flesh unpalatable. In the fresh-run condition the flesh has a beautiful red color, resembling that of the red salmon, but not so brilliant. Early in July the red color of the skin is somewhat remarkable in being interrupted at intervals along the sides, causing a sort of resemblance to bands. The average weight is about 12 pounds, but some individuals reach 20 pounds.

This species is found chiefly in the small rivers and creeks, and is usually very abundant in all parts of the Territory as far north as Hotham Inlet, and probably Point Barrow. In the rivers of California and British Columbia it is said to appear seldom or never in the spring, but in Alaska it makes its appearance on the coast in great schools about the middle of June and continues abundant for nearly a month, after which it decreases rapidly in numbers, disappearing usually about the time of the forming of the ice.

In the small streams falling into Alitak Bay, with only a few exceptions, this fish and the little humpback are the principal salmon, and the natives dry them for winter use in large quantities. The Sturgeon River, according to Mr. Charles Hirsch, never contains any but dog salmon and humpbacks. In the Karluk River the dog salmon is only an occasional visitor. At St. Paul, Kadiak, Mr. Washburn says that the *Hyko* arrives about July 1, and there is only one annual run. On the 30th of August, at Karluk, a haul of a large seine yielded forty dog salmon and only one red salmon.

Early in July the fish-drying frames of the natives on the shores of Cook Inlet are red with the flesh of the drying dog salmon, or *Hyko*. The natives cut off the head, split the fish in halves, and remove the backbone, allowing the two halves to remain fastened at the tail. The sides are gashed at short intervals in order to facilitate the drying. The fur-traders lay in a large stock of this dried salmon, which is known to the trade as *ukali*.

The Silver Salmon (*Oncorhynchus kisutch*). Plate IV, Fig. 1.

The silver salmon is considered an excellent fish in the Puget Sound region, but is not so highly esteemed in the northern part of Alaska. It is used to some extent for canning, but is far less important for this purpose than the red salmon. It reaches a weight of about 30 pounds; the average weight in Alaska is less than 15 pounds. In Alaska, as in the Puget Sound region, it is a fall-running fish. It does not ascend the streams to any great distance, and I have seen spent fish of this species coming down alive in the fall to within easy reach of salt water. Whether the species actually leaves the fresh water after spawning is uncertain. There is a conflict of observation on this subject. Mr. J. W. Clark, agent of the Alaska Commercial Company at Nushagak, a very reliable and intelligent man, states that he has seen silver salmon come down the river alive in the spring. In some other Alaskan rivers, Capt. Lansburg, superintendent of the Thin Point cannery, has seen only black and lank-looking salmon of this species during the winter.

At Afognak the species arrived August 5, 1889, but there was no extensive run till about the end of the month. A small silver salmon was seen at Karluk August 4. The species was not abundant there, however, until early in September, when about 7,000 were caught at one haul of the seine. It was about this time that one of Capt. L. P. Larsen's men at Karluk hooked a very large silver salmon, probably weighing over 30 pounds. This species is only an occasional visitor at Karluk. When it runs there it generally begins about the last of August, according to Mr. Charles Hirsch. Mr. Washburn informed me that it arrives at St. Paul late in August or in September, and that there is only one annual run. A few fish of this species are found in the small river in Olga Bay, near the cannery of the Arctic Packing Company. It has been stated by Mr. Daniel F. Bradford that silver salmon do not furnish 10 per cent of the pack at the fisheries. In the river at Thin Point, a small and very shallow but constant stream, both silver and red salmon are found, the latter predominating. The season closes here early in September.

The silver salmon make their nests among the gravel and stones, from which they clean all dirt and slime. They use their snouts in collecting material for the nests, and Mr. L. M. Turner states that he has seen them with the snout worn off past the muzzle. After the spawning season, and during their stay in fresh water, they continue to be very much emaciated and in poor condition generally.

No decrease has been observed in the supply of this salmon as far as we are informed. Its late arrival in most localities limits the season during which it can be caught, and this serves as a sort of protection for the species.

The Humpback Salmon (*Oncorhynchus gorbuscha*). Plate III, Figs. 1 and 2.

This is the smallest, most abundant, and most widely distributed of the Alaskan salmon. Its average weight is about 5 pounds, and individuals weighing 10 pounds are very uncommon. It may be recognized readily by its excessively small scales, and, in

the breeding season, by its greatly distorted jaws and enormous hump. It is found in all parts of the Territory. Its range is known to extend several hundred miles to the eastward of Point Barrow, and probably includes the Mackenzie. Speaking of its extraordinary abundance, Mr. Turner has aptly remarked that "they appear at the surface of the water like the pin-drops of an April shower."

Mr. Charles Hirsch has informed me that from about the 6th of July, 1880, there was in the Karluk River, continuing for five weeks, a glut of humpback salmon which kept all other salmon out of the river. It was impossible to pull a boat across the stream, owing to the great quantities of salmon. A haul was made with a 15-fathom seine at 6 a. m., and the men were dressing fish from that haul until 6 p. m. About 140 barrels were dressed. These were loaded in bulk into a small schooner, and then the men were occupied three hours in clearing the seine, in which the remaining salmon were about 4 feet deep. In the season of 1891 not more than 100 of these salmon were caught at Karluk up to the close of the fishing, October 5.

The humpback arrives at St. Paul, Kadiak, about the 10th of July, and there is only one run a year. From the statement of Mr. Hirsch, above referred to, it will be seen that it makes its appearance on the western side of the island at about the same time. Mr. Turner records the date of arrival at St. Michael as about the 25th of July and the period of running about five weeks. Mr. Nelson's earliest specimens were taken at St. Michael July 24. He says they are rather numerous until the end of July, with more or less common stragglers until late in the fall. The writer found humpbacks in good condition in Plover Bay, Siberia, about the middle of August.

The species continues to enter the rivers usually for a period of about five weeks, but is not regular in its appearance. The enormous run in the Karluk, mentioned above, was exceptional, for the fish seldom enters that river. In the Yukon, during some years, according to Mr. Nelson, only a few are taken, and at other times they are present in such excessive numbers in the lower part of the river that the fish-traps must be emptied several times a day.

This salmon is much addicted to jumping out of the water. In the vicinity of St. Paul, Kadiak, one of the commonest sights was this breaching of the humpback salmon. Fishermen at this village say that the sea-run humpback often contains a small fish, which, from their description, must be the capelin.

In the Karluk River, as already mentioned, the species continued to enter for five weeks, and then dead fish began to float down the stream, and this continued about a month. It does not go far from salt water and frequently enters streams which are too shallow to cover its fins. Its business in the fresh waters is simply to deposit its eggs, after which, apparently, it dies on the spawning-grounds or is carried to sea in a dying condition. Spawning takes place within a few rods of the sea. It is a common thing to see large areas of the bottom entirely covered with the eggs, either lying unprotected on the gravelly bottom or partly concealed in crevices between moderately large stones. In Afognak River the eggs were cast among stones about half as large as a man's fist.

There are no signs of diminution of the supply of this fish. A small number are salted annually, and the natives dry large quantities for winter use.

In the fresh-run condition this is one of the most palatable salmon in Alaska, and the time is not far distant when it will be a very important species for canning. The

flesh is somewhat paler than that of the red salmon, yet it has a beautiful color. Properly introduced into the markets this would become a very valuable fish, and its wonderful abundance would establish a great industry.

The height of the spawning season in the Kadiak streams is evidently about the middle of August. In Alexander Creek, near the Larsen Cove cannery of the Arctic Packing Company, Messrs. Robert Lewis and Livingston Stone found the humpbacks spawning in vast numbers August 15. Mr. Lewis took some of the eggs and fertilized them with the milt of the males. The eggs are larger than those of the red salmon, but smaller than king salmon eggs and not so bright red. On the 22d of August, 1889, this fish was observed in the small streams at the head of the west arm of Uyak Bay trying to run up the rapids in order to spawn. The current in some places was so swift as to wash the fish away. Eggs were very plentiful between the crevices of the stones. On the 24th of August Alexander Creek was full of humpbacks in all stages of emaciation and decay. In Alitak Bay, September 9, the fish were nearly all dead in the creeks, and Snug Harbor contained many dying humpback salmon floating seaward tail first. Messrs. Booth and Stone found Afognak River well filled with spawning humpbacks August 30. The two tributaries of Afognak River also contained them in great numbers. Mr. Booth found the fish most abundant in the neighborhood of holes excavated in the egg-sized gravel of the bottom, intermingled with stones of 3 or 4 pounds in weight.

After the great run in the Karluk, already referred to, the fish came down dead or in a dying condition for a whole month and the beaches were strewn with dead salmon. The distortion of the humpback during the breeding season is remarkable and the injury to its fins, and other exposed portions of the body, is excessive. The last stages of this species are repulsive to look upon, but before the extensive emaciation and sloughing away of the skin has taken place the colors of the breeding fish are rather pleasing, the lower parts becoming milky white, contrasting beautifully with the darker color of the sides and back. This white color sometimes extends upward toward the middle line with interruptions.

The Red Salmon (*Oncorhynchus nerka*). Plate II, Figs. 2 and 3.

This is the blueback of the lower Columbia River, the *Sawqui* or *Sukkegh* of the Frazer River, and the *Krasnaya Ryba* (or redfish) of the Russians. It does not seem to exist south of the Columbia River. Northward it is found as far as the Yukon, and it occurs also in Japan and Kamschatka.

Although next to the smallest of the Pacific salmons this is now the most important species for canning and salting, and its flesh is so red as to win for it a reputation not warranted by its edible qualities. It approaches the shores early in the spring and enters only snow-fed streams. The red salmon is not caught, like the king and silver salmon, by trolling in the bays. When it comes into the mouths of the streams, to ascend for the purpose of spawning, the fishing begins.

The size of the red salmon varies with the locality and season. Some runs contain much larger fish than others. At Karluk the fish will average nearly 4 pounds apiece without the head, fins, tail, and viscera. The whole fish will weigh 7 or 8 pounds. In 1889 it was estimated that 13 fish would make a case (48 pounds) of canned salmon; in 1891 the number to the case was stated to have been 15. Individuals of 15 pounds are occasionally seen, but they are uncommon.

Like the king salmon, the red salmon travels long distances up the rivers, pushing on to their sources; but it is chiefly a lake spawner, while the king salmon prefers the headwaters of the principal rivers to their small tributaries.

Red salmon arrive at St. Paul, Kadiak, according to Mr. Washburn, agent of the Alaska Commercial Company, in June, and there is only one annual run. This gentleman also states that there is a little run of small red salmon in Little Afognak River as early as April 1, but the principal run comes in June or July. In a river just 10 miles distant from the Little Afognak the first run does not arrive until about May 20. At Karluk, in 1889, and around Kadiak generally, the species arrived late, and the catch up to the end of July was small everywhere. Turner records the 1st of May as the time when the natives of Attu Island prepare weirs (*zapor* of the Russians) to obstruct the passage of the red salmon to their spawning-grounds. The species does not appear to be common on the coast of Norton Sound, according to Mr. Nelson, but is more abundant in the Lower Yukon, the main run occurring about the middle of August and lasting sometimes only two or three days, but usually a week or ten days.

At the end of August, 1889, the red salmon were still running into Karluk River, but had greatly diminished in numbers and had become so dark in color as to be unfit for canning. In 1890 the run continued at Karluk very late, and a large portion of the catch was obtained in October and early in November. At Afognak the run usually lasts only during the first three weeks of July, although they first appear about the middle of June, and a few small ones occasionally come about the 1st of April. The runs of fish appear to vary a good deal from year to year. Some of the fishermen at St. Paul believe that every fourth year is a good salmon year. Mr. Hirsch says that in Cook Inlet, the Ninilchic, Kusilov, Kenai, and Sushitna rivers all have salmon runs, but the kind of fish varies from year to year. An unexpected run of humpbacks may prevent the red salmon altogether from entering its chosen river.

Mr. Hirsch also says that in coming from the sea the red salmon approach from all directions. They have been seen about 1½ miles distant from the land, and when they approach nearer the schools break up. This species is very much given to jumping entirely out of the water, and it is not unusual to see a dozen or more in the air at a time. At Karluk the fish play around in the kelp beds, especially when frightened by the seines, and here they are perfectly safe from the fishermen. They do not linger long in salt water after arriving on the coast. Fresh-run fish sometimes go into the river with the tide and out again the same day with the ebb.

Young fish occasionally accompany the adults, but all I examined proved to be males. On the 13th of August, 1889, I obtained a male red salmon 11 inches long to the root of the tail. This example contained numerous intestinal worms.

It is asserted by Mr. Hirsch and others, who have had much experience with the red salmon, that no spawning fish of this species ever leave Karluk River alive. Natives of Karluk say that they can catch salmon any time during the winter through the ice on Karluk River and lake. They assert, also, that all the red salmon die in the spring, most of them in April.

After entering the rivers the red salmon may return to the salt water, but if the spawning season be near at hand and the spawning-grounds remote, they travel up the stream very rapidly. I have seen them playing about in the rapids, apparently

resting, during the ascent of the Karluk. Numerous beds of eel-grass and other aquatic plants furnish attractive hiding-places in which the fish sometimes linger.

The red salmon ascends to the lake or lakes which the river drains, and it is said that this species will not enter a river which does not arise from a lake. The distance traveled in the Karluk is less than 20 miles, and the principal lake is 8 miles long. Red salmon spawn in this lake and in the short and rapid rivers connecting each of its arms with smaller tributary lakes. They ascend long rivers, like the Columbia, more than 1,000 miles, to reach the spawning lakes.

This salmon begins spawning soon after its arrival on the coast, and this varies with the locality. The season usually begins in June, and fish which have not yet spawned continue to arrive as late as the beginning of September. Spawning takes place in August, as the writer knows from personal observation. Dead fish and others which have spawned and are already dying are very abundant about the middle of this month. In Karluk Lake, near the sources of the river, ripe red salmon were speared by the natives August 17, 1889. On the 18th of the same month large numbers of dead salmon of this species, and plenty of both sexes which were spent and nearly dead, were found in the rivers connecting Karluk Lake with its tributary lakes. In all of the little streams falling into Karluk Lake, in which red salmon were found, dead fish were moderately common; and there was an abundance of young salmon about 1½ inches long, which must have been hatched from eggs deposited during the preceding fall. Mr. Charles Hirsch stated that "in March or April the Karluk River is solid full for a whole month of salmon fry going down to sea."

I have seen salmon nests at the head of Karluk Lake in shallow water near shore between the mouths of two streams. The nest is a hollow circular pile of stones, and the eggs are placed in the crevices between the stones. In the river connecting the east arm of Karluk Lake with its tributary, additional nests of salmon were observed. In some cases streams fall down into Karluk Lake over bluffs which are too steep for the salmon to ascend, and the fish were spawning at the mouths of such streams.

Extensive changes take place in the color of the red salmon as the spawning season approaches. After a period in fresh water the skin becomes dark and the beautiful red color of the flesh gives place to a paler tint. In this condition the fish has no commercial value. According to Mr. Bradford, the arrival of dark-red salmon in quantities later in the season at Karluk indicates a decrease in the run. In the height of the spawning season the sides are suffused with a brilliant vermilion, and the head is a rich olive-green, contrasting sharply with the color of the body. The male develops a hump nearly as large as that of the humpback, and its jaws are greatly enlarged.

The eggs and young of the red salmon have many enemies, and the percentage of fish naturally developed from eggs must be exceedingly small. Every salmon nest has its greedy horde of little fresh-water sculpins (otherwise known as miller's thumbs), blobs, and bullheads (*Uranidea* spp.), always in readiness to consume the fresh eggs. The shoal waters around the shores of Karluk Lake, and the shallow streams into which the red salmon finds its way for reproduction, contain myriads of these destructive little sculpins. Another source of destruction to the eggs is found in the dolly varden trout (*Salvelinus malma*), which is only too common on the spawning-grounds of the salmon and consumes large quantities of eggs. The waters referred to contain, also, a great many sticklebacks (*Gasterosteus* sp.), some of them of very large size, which probably destroy eggs.

Chief among the destroyers of the young fish are terns, gulls, ducks, and loons, which are very common in that region. I have shot terns and gulls near the south end of Karluk Lake, and upon holding them up by the legs small salmon dropped out of their mouths. Towards the end of August, 1889, the shallow parts of Karluk River were visited by hundreds of gulls, chiefly young of *Larus glaucescens* and *L. brachyrhynchus*, which were feeding upon young salmon. Bears consume large quantities of the breeding fish. They may be seen standing at the edge of the stream, where the water is shallow, and occasionally striking salmon with their claws and throwing them on the shore, where they are eaten alive. I have seen red salmon partly eaten, but still alive, lying on the shore after the retreat of the bears, which were disturbed while feeding. Other enemies of the salmon attack it in the sea; among them are the salmon shark (*Lamna cornubica*), porpoises, and sea lions. All species of salmon are more or less covered with parasitic *copepods*. The estuary of Afognak River is generally left bare at low tide, and great numbers of salmon are thus stranded, many of which die before the next tide rescues them.

Red salmon are seen in salt water off the mouths of the rivers in large schools in the spring. No attempt has been made to take them until they come to the shore.

The catch of red salmon has been increasing, owing to the greater number of persons engaged in the fishery and the superior effectiveness of the implements used in its capture. The size of seines has been greatly enlarged, and the number of boats and seines largely augmented. There was, early in the season of 1889 and in previous seasons, injudicious obstruction of the ascent of spawning fish in the Karluk River. At one time an impassable weir, similar to the *zapor* of the Russians, was placed in this river. I have also seen the remains of pound nets made of wire netting, which interfered so seriously with the ascent of the fish that they were dismantled by unknown parties and were not reëstablished.

The Steelhead (*Salmo gairdneri*). Plate v, Fig. 1.

This large black-spotted trout is known also as hardhead and Gairdner's trout. The Russian name is *Soomga*. In some of our eastern markets it is sold as "Kennebec salmon" before the Atlantic salmon has come in from the sea. In the Rogue River, Oregon, the fishermen call it Rogue River trout.

It sometimes reaches a weight of 30 pounds, and individuals of that size bear a close resemblance to *S. salar*. It is found from Monterey, Cal., to Bristol Bay, Alaska, and is very abundant in some parts of the Gulf of Alaska. This trout has been considered a winter spawner, but females full of ripe eggs were seen by me near Sitka, June 10, 1880. Spent fish of this species are frequently taken with the spring run of the king salmon, so that in all probability the usual spawning time is late in the winter or very early spring.

This species, according to Mr. Charles Hirsch, arrives at Karluk in August in small numbers. I have seen a moderately large number of steelheads at Karluk on September 4, but their abundance was nothing in comparison with that of other species. It is seldom used at Karluk. A few small individuals are dried there by the natives.

The spawning habits of the steelhead are scarcely known. Mr. B. F. Dowell has recorded its arrival in May in Applegate Creek, Oregon, for the purpose of spawning. At the falls in the Willamette River, at Oregon City, Mr. Waldo F. Hubbard, of the U. S. Fish Commission, reported a few ripe females about the middle of May, 1892,

but during the remarkably high water the fish passed over the obstructions and no eggs were secured. At Sitka I was told that it spawns in lakes not far from the sea, and immediately after spawning goes into the salt water.

In the opinion of Mr. Dowell the steelhead is "delicious in flavor."

The Red-throated Trout (*Salmo mykiss*). Plate IV, Figs. 2 and 3.

Clark's trout has recently been called the red-throated trout on account of the characteristic crimson streak around the throat. It is a large and extremely variable species, and its distribution is nearly or quite as extensive as that of the lake trout. One of its varieties is found in streams of the Sierra Madre, Mexico, at an elevation between 8,000 and 9,000 feet, in the southern part of Chihuahua, near the boundaries of Durango and Cinaloa. In Alaska it has been traced as far north as the Kuskoquim River, and doubtless extends still farther.

As a food-fish the red-throated trout is excellent and the species grows to a large size, individuals weighing 20 pounds being recorded. Although not now an important commercial fish in the Territory, it furnishes food for the natives and is taken in large numbers by anglers.

In the Rocky Mountain region it is represented by numerous varieties and is well known to fishermen and tourists. These are generally known as Rocky Mountain trout and may be readily distinguished by their black spots and the crimson dash on the throat. In the mountain lakes and streams of Colorado the trout come down to a point where the summer temperature reaches 60° to 65°. In the basin of the Colorado they are associated with small dace-like minnows, upon which they feed. They prefer clear streams with gravel bottoms. The species is not migratory.

In the Yellowstone National Park this trout occurs in both the Atlantic and Pacific watersheds, having traversed the waterway over Two-Ocean Pass.

The typical red-throated trout of Alaska differs materially in color from its Rocky Mountain representatives, having comparatively few large, roundish, black spots on the body, chiefly above the lateral line and evenly distributed along the surface; the head has a few black spots; the dorsal and caudal have a moderate number of black blotches which are usually oblong in shape.

Parasitism in the Rocky Mountain trout has been discussed by Dr. Yarrow in papers referred to below, and more recently by Dr. Jordan and Prof. Linton in the ninth volume of the U. S. Fish Commission Bulletin.

Gordon Land, fish commissioner of Colorado, has obtained eggs from this species on June 21 and they were hatched in 25 days in water varying in temperature from 52° Fahr. at night to 62° at midday; the eye-spots were plainly visible in 17 days from the time of taking the eggs. Mr. Land states that this trout is "easily taught to feed and will readily take food from the bottom as well as in transit."

An excellent account of the life history of the red-throated trout was published by Dr. H. C. Yarrow in the Report of the U. S. Fish Commission, Part II, 1874, in advance of its appearance in the Zoölogy of the Wheeler Survey Report in 1875. Under the name *Salmo virginalis* he treats particularly of the spawning, feeding, and movements of the species. From inquiry and personal observation he fixed the maximum length of the fish at 3 feet and the weight 15½ pounds; but the average

length is about 14 inches and the weight 1½ pounds. The following extracts have been rearranged from Dr. Yarrow's description:

In shape there is very little difference between the male and female, though near the breeding season the female is the larger and more brilliant in color. This increased brilliancy of color affects both sexes, but is noticeable in a more marked degree in the female. About breeding time the eyes are brighter, scales more brilliant, and the superficial blood vessels more fully engorged than ordinarily; the movements are more rapid, a celerity being displayed quite at variance with its usual somewhat sluggish habits. As far as could be ascertained, the spawn has not been observed to run from this fish when captured, either by the line or net, for the reason, most likely, that the gravid female is seldom taken just prior to or during the time of spawning. It first enters the mouths of mountain streams and rivers to spawn about the middle of March, remaining until the middle of May, by which time the majority have fulfilled their reproductive functions. In coming on to the breeding-grounds all sizes are found together, young and old, little and big. During the spawning season no very observable changes take place in the trout, except those mentioned above, and also that the under part of the cheek of the female becomes very bright. As a rule, it may be stated that in general appearance the male is much less bright than the female at this season, and smaller.

Before spawning, the nests are made in the sand or gravel by a rotary motion of the tail of the male. The eggs are exuded by the female into this cavity, which is sedulously guarded by the male until the process is completed, when the latter deposits the milt which is to impregnate the eggs. No further care is taken by either after the deposition of the impregnating substance. Most of the spawning is done in the rivers, but the process takes place in the lakes also to some extent. It is not known at what age this fish begins to breed nor what period of time the process continues. The act of spawning exerts an injurious effect on the flesh of the fish, rendering it poor and insipid. In addition, many of the fish seeking the upper parts of the rivers to fulfill their reproductive duties do not survive the severe bruises and other injuries they meet with in their journey past the rocks and through the rapid currents of the mountain streams. The water in the locality in which the trout spawns has never been noticed to be whitened by the milt, but it does present a translucent pinkish appearance after the event.

The temperature of water most favorable for hatching appears to be the coldest obtainable, the eggs in many cases being laid directly on the bottom of ice-cold mountain springs. The color of the spawn is whitish pink, each egg just previous to spawning being the size of No. 4 shot. In July the eggs are not larger than No. 12 or dust shot. The eggs when spawned always sink to the bottom, where they remain unless eaten or carried away by the swift current. The eggs are hatched in March, April, and May, but the number of days required by the process is not known. The spawn and young fish suffer greatly from the attacks of other fish, aquatic reptiles, and even from the large fish of their own species, these seeming to have no affection for their young. Mr. Peter Madsen states it as his opinion that the female in spawning ejects only a portion of her eggs, as he has found, on dissecting the trout after the spawning season, eggs of various sizes, some very small and others full grown.

After spawning the trout invariably swim in schools from one part of the lake to the other in search of food, a solitary fish at such time being seldom seen. In traveling the trout is nearly always accompanied by its friendly companions, the mullet, sucker, etc., which share with it the danger of attack by man and birds. It is rather a singular fact that the very young trout is seldom seen or taken either by hook or net, and I am unable to account for the same unless it is that it resorts to unknown localities until a larger growth is obtained. Its food, so far as known, consists principally of small insects.

The trout is very voracious, devouring other fish smaller than itself, particularly a species locally known as "silversides," or "leather-sided minnows" (*Clinostomus tænia*, Cope), of from 2 to 6 inches in length; on dissection, I found the stomach of the trout crammed with these little fish. Grasshoppers, too, are a source of diet to the trout, with flies and other insects, while they do not disdain even snakes and frogs of tolerably large size. The favorite localities for feeding in the summer are close to the mouths of rivers, the water of which from the mountains is ice cold, from 10 to 12 feet deep, and the current very swift.

This fish winters in the deepest waters of the lakes, as most of the mountain streams to which it resorts in spring and summer are shallow and very cold. In summer it swims low in the water—it is thought, to avoid the extreme heat of the sun. The male and female, large and small, run indiscrimi-

nately together, the presence of this fish in any particular locality being indicated by the presence of flocks of birds hovering over the water.

Large captures are easily made with a hook, and I have taken 30 to 40 pounds weight in a single hour's fishing. The hooks used are large steel ones, with a snood or snell of piano wire, which is strong and flexible. The best bait is minnow and grasshopper, although this trout will bite at almost anything. In Panquitch Lake a fish's eye is considered a very tempting bait.—(Dr. H. C. Yarrow, Report Wheeler Survey, vol. v, Zoölogy, pp. 686–691).

The Rainbow Trout *(Salmo irideus)*. Plate v, Figs. 2 and 3.

The rainbow trout is not known to extend far into Alaska, but specimens have been obtained at Sitka by Capt. L. A. Beardslee, U. S. N. It is sometimes found in salt water, but spends most of its life in the streams. It is a valuable food-fish and grows to a large size, reaching 2 feet in length and about 8 pounds in weight.

At the Baird station of the U. S. Fish Commission spawning takes place in the small creeks tributary to the McCloud River, from January to May. The eggs are about one-fifth of an inch in diameter and vary in color from light straw to deep salmon-red. A 2 pound trout yields about 800 eggs. In water at 54° F. the eye-spots show in 12 days and the period of incubation lasts 26 days. The outline of the embryo can be seen through the shell four or five days before the eye-spots appear.

The rainbow trout derives its name from the broad red or crimson band which extends along the side and on the head; this contrasting with the rich silvery gray of the body and the iridescence of the sides gives the fish a beautiful appearance. In the spawning season the color of the body becomes much darker, the flesh paler, and the red stripe turns to crimson.

This species feeds chiefly on salmon eggs during the season and upon dead salmon. It is very fond, also, of the larvæ of the caddis fly. Mr. Loren Green believed that these trout stir up the bottom of the river with their tails when searching for food. According to Mr. Stone they have the peculiarity of swimming partly on one side when in search of food, with one eye inclined downward, so that they see what is on the bottom. In very hot weather they feed chiefly at night.

The fishing lasts from the middle of May to the last of November, June and July being the best months.

A disease has sometimes appeared among the rainbows, which has caused great mortality. Specimens of the diseased fish were examined by Prof. S. A. Forbes, who attributed the deaths to encysted parasites located principally in the kidneys. but also affecting the liver and spleen.

The Lake Trout (*Salvelinus namaycush*). Plate vi, Fig. 1.

The lake trout is the largest trout of the world and one of the largest, if not the largest, of the salmon family. It is indigenous to North America, occupying the northern portion of the continent, extending south to Silver Lake in Pennsylvania and Henry Lake in Idaho, and most highly developed and most abundant in the Great Lakes region, and extending northward to the Arctic Ocean on both sides of North America. In Alaska this trout is very abundant in the rivers and lakes of the northern part of the Territory. It has been found as far north as the Putnam or Kuwuk River, which falls into Hotham Inlet, and extends southward to the peninsula of Alaska. In color, the Kuwuk specimens resemble examples of the same species from Labrador, differing only in being slightly darker.

The color variations in this trout are remarkable; some examples are nearly black, others are brown with vermilion spots, still others are gray, with chain-like markings. In the Great Lakes the usual color is brownish gray, profusely dappled with whitish blotches. On account of its wide range, it naturally runs into many varieties of form and color, and adult individuals differ greatly in size in different localities. It is said that individuals weighing 120 pounds have been taken, but the average weight in the Great Lakes will probably not exceed 15 pounds, and an example weighing 80 pounds is regarded as the largest one ever taken in Lake Superior. The extreme weight above mentioned is given on the authority of Dr. Richardson, whose observations were made in Arctic North America. The Alaskan examples which I have seen were comparatively small, but Mr. Townsend and others who obtained these specimens state that the species grows to a large size in that Territory.

The lake trout is a voracious and predatory species. It associates with the white fish and lake herring, which constitute the principal part of its food. It devours other species of fish of suitable size, including the burbot or lake lawyer. Among the singular articles which have been found in the stomach of this trout are "an open jackknife (7 inches long, which had been lost by a fisherman a year before at a locality 30 miles distant), tin cans, raw potatoes, chicken and ham bones, salt pork, corn cobs, spoons, silver dollars, a watch and chain, and in one instance a piece of tar rope 2 feet long. In the spring wild pigeons are often found in their stomachs. It is thought that these birds frequently become bewildered in their flight over the lakes, and become the prey of the trout."

The lake trout appears to spawn only in the lakes, and not in rivers tributary to them. In lakes Michigan and Superior spawning takes place late in October, on rocky shoals and reefs, in water 70 to 90 feet deep. The eggs are said to be deposited in clefts in the rocks, into which they settle and remain until hatched. The young make their appearance in January or early in the spring, in water of a temperature of 47° Fahr. The hatching has been known to take place about the end of January. The late James W. Milner found some hatching-grounds at the head of Lake Huron, in depths of from 7 to 90 feet on rock bottoms. In a female weighing 24 pounds he counted 14,943 eggs.

In Lake Michigan Mr. Milner found that the lake trout, except in the spawning season, remains in the deepest part of the lake, and in their fall migrations they do not ascend the rivers nor are they found in outlets of the lakes. In northern Lake Michigan the fish are caught through the ice in winter in depths of more than 180 feet. The Indians of Sault Ste. Marie spear the lake trout through the ice, first decoying them within reach by means of a decoy of wood or lead roughly shaped like a fish.

In Alaska the lake trout becomes very plump, and on account of its great size and the good quality of its flesh it is a very important source of food for the natives. It has not at present any importance in the commercial fisheries, but must become a valuable market species in the future.

The Dolly Varden Trout (*Salvelinus malma*). Plate VI, Fig. 2.

This handsome species bears a very close resemblance to the sea trout of Labrador. It is known to commerce under the name of salmon trout. The Russian name of the species is *goletz*, and in Kamchatka it is the *malma*. In western Montana it is known as salmon trout and bull trout, the latter name being current also in California.

The name dolly varden was in use for it at Soda Springs, Cal., at least as early as 1872. The McCloud River Indians call it the *Wye-dar-deek-it*. In the McCloud its weight varies from 2 to 15 pounds. According to Mr. J. B. Campbell—

> It frequents the river from the junction (with the Pitt) to the spring, there being none above the spring and few near the river mouth. If one takes hold of the dolly varden it slips away nearly like an eel. The species is very destructive to other trout, or any kind of fish. It spawns in September and November. The eggs are about one-half the size of those of the common (rainbow) trout. The fish are very difficult to obtain. They will live in a small place where the common trout would not. I have kept them in a pond about 6 feet square for a month, where the rainbows would kill themselves in a short time. They appear to be more hardy.

The average weight of this trout in the sea fishery at Kadiak is about 2½ pounds. It reaches a length of 30 inches, and individuals weighing 8 pounds are often taken. It increases in size to the northward.

The dolly varden is a migratory species and passes much of its time in the sea near the river mouths; it enters the rivers late in the fall and descends in the spring. Mr. Washburn says that it arrives at St. Paul in April. It remains in the bay near St. Paul throughout the summer. Mr. Charles Hirsch states that it reaches Karluk in the latter part of May and runs through the whole season. Dolly vardens of a pound or more can be found in the streams at any time during the summer. Mr. E. W. Nelson found them at Unalaska early in June, and in the Yukon in the same month, but he says they are most numerous in the fall just before and after the streams freeze over. They enter the rivers and go up to their headwaters for the purpose of spawning. The spawning season is in winter and may begin very early in this part of the year. A female, opened on the beach at Karluk August 2, 1889, contained eggs which seemed to be nearly ripe.

Individuals taken at sea sometimes have capelin in their stomachs. In Karluk River, near its mouth, I have seen them feeding on eggs of the red salmon, which had been thrown into the water from the fish-cleaning houses. On the 5th of August I found a female dolly varden with very small ovaries; this example was long and slender. On August 16 a spent or sterile *malma* was found above the rapids in a little stream tributary to Karluk River. At the head of Karluk Lake, August 19, was discovered a very much emaciated trout of this species, which was struggling in the water and nearly dead. The inside of its mouth was full of large lernæan parasites.

The dolly varden spends the entire summer in salt water near the mouths of the rivers after it has reached a certain age; younger individuals remain in the rivers and lakes. Many thousands of these trout are caught in the seines hauled for salmon, and fisheries exist for this species alone in various localities. It is put up in pickle and sold in San Francisco. The demand there, however, is limited.

No serious diminution of the supply of this trout has been observed. There is great destruction of the fish, however, at Karluk in the seining for red salmon, where thousands of dolly vardens are taken and left lying unused on the beach. Something should be done to prevent this waste of good fish.

BIBLIOGRAPHY OF THE SALMONIDÆ OF ALASKA AND ADJACENT REGIONS.

BY TARLETON H. BEAN, M. D.,
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Owing to lack of time it was found impossible to furnish a complete bibliography of publications relating to the *Salmonidæ* of Alaska and adjacent regions. A more detailed catalogue, however, is in course of preparation for publication in the Bulletin of the U. S. Fish Commission for 1892. In the compilation of the following list of papers free use has been made of the "Bibliography of the Fishes of the Pacific Coast of the United States to the end of the year 1879," by Theodore Gill. The "Partial List of Charts, Maps, and Publications relating to Alaska and the Adjacent Region from Puget Sound and Hakodadi to the Arctic Ocean, between the Rocky and the Stanovoi Mountains," by W. H. Dall and Marcus Baker, to which reference is made below, will furnish many additional titles.

1811—Zoögraphia Rosso-Asiatica, sistens Omnium Animalium in extenso imperio Rossico et adjacentibus maribus observatorum Recensionem Domicilia, Mores et Descriptiones, anatomen atque Icones plurimorum. Auctore Petro Pallas, Eq. Aur. Academico-Petropolitano.—Volumen tertium.—Petropoli in Officina Caes. Academiæ Scientiarum Impress. M. DCC. CXI. Edit. MDCCCXXXI. (4°, vii, 428, cxxv. pp.,6 pl.) *Salmo lagocephalus* (p. 372, pl. 77, f. 2.) *Salmo proteus* (p. 376, pl. 78, f. 2, pl. 79.) *Salmo socialis* (p. 389, pl. 81, f. 2).

1836—Fauna Boreali-Americana; or the Zoology of the Northern Parts of British America: containing descriptions of the objects of Natural History collected on the late northern land expeditions under command of Captain Sir John Franklin, R. N. Part third. The Fish. By John Richardson, M. D., F. R. S., F. L. S., Member of the Geographical Society of London, and Wernerian Natural History Society of Edinburgh; Honorary Member of the Natural History Society of Montreal, and Literary and Philosophical Society of Quebec; Foreign Member of the Geographical Society of Paris; and Corresponding Member of the Academy of Natural Sciences of Philadelphia; Surgeon and Naturalist to the Expeditions. Illustrated by numerous plates. Published under the authority of the Right Honorable the Secretary of State for Colonial Affairs. London: Richard Bentley, New Burlington street, MDCCCXXXVI [4°, pp. xv, 327 (+1) 24 pl. (numbered 74–97).]

[*Salmo scouleri*, pp. 158, 223; *Salmo quinnat*, 219; *Salmo Gairdneri*, 221; *Salmo paucidens*, 222; *Salmo tsuppitch*, 224; *Salmo Clarkii*, 225, 307; *Salmo (Mallotus) pacificus*, 226.]

1846—A Synopsis of the Fishes of North America. By David Humphreys Storer, M. D., A. A. S. Cambridge: Metcalf and Company, Printers to the University. 1846. [4°, 1 p. l. (=title), 298 pp.]

[*Salmo quinnat, Salmo Gairdnerii, Salmo paucidens, Salmo scouleri, Salmo tsuppitch, Salmo nitidus, Mallotus pacificus.*]

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[N. sp., *Salmo iridea.*]

1857—The Northwest Coast; or, Three Years' Residence in Washington Territory. By James G. Swan. (Figure of Terr. seal.) With numerous illustrations. New York: Harper & Brothers, Publishers, Franklin Square. 1857. 12°, 435 pp. (incl. 26 figs. and pl.); frontispiece, 1 map.

[Popular notices of fishes—especially salmon and fishing for salmon—are given in chapters 3, 7, 9, and 14.]

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[Fishes noticed at pp. 202–203.]

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[§ 1–4, n. sp. "*Fario Newberrii*, or else *Salmo Newberrii*" (225).]

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Chapter I. Report upon the Salmonidæ. pp. 307–349.)

[N. sp. *Salmo Masoni* (345).]

[This volume also appeared with the following title page and modifications:—]

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[Zoology, chap. vi (pp. 140–146); fishing (pp. 313–317).]

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[N. sp. *Salmo lordii* (148).]

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Chapter vii. Zoölogy. pp. 434–501.

Fishes. [By J. G. Cooper, M. D.] pp. 487–498.

Fisheries. p. 680. *Salmonidae: Salmo Scouleri, Masoni, stellatus, iridea, pretiosus.*

[The list of fishes was evidently prepared by Dr. J. G. Cooper, although only general acknowledgment for assistance was rendered in the preface. It was acknowledged by Dr. Cooper, as author, in the communication to the California Academy of Sciences, indicated above. Inasmuch as this was intended to be a complete enumeration of the fishes of California, the names are reproduced here.]

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[Contains many references to the fish of the Territory throughout; Chapter VI, Part II, is devoted entirely to fisheries and other resources, while the Appendix (p. 579) gives list of the fishes of Alaska.]

1870—Über einige Pleuronectiden, Salmoniden, Gadoiden und Blenniiden aus der Decastris-Bay und von Viti-Levu. Von Franz Steindachner und weil. Prof. Dr. Rudolph Kner. Sitzb. K. Akad. Wissensch., B. 61, Abth. i, pp. 421–447, pl. 1, 1870.

[Species identified as common to Decastris Bay and the American coast.]

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[14 species specified: no new species described.]

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Appendix No. 4. Special Report by Mr. S. Wilmot on the Salmon Fishery and Fishery Regulations of Fraser River, B. C. 1. The Canning Industry; 2. The Fishery Regulations; 3. Supplementary Pages, 63–77, four colored plates.

1892—Bulletin No. 4. Salmon and Trout of the Pacific Coast. By Dr. David Starr Jordan, president of the Leland Stanford Junior University. Sacramento: State Office, A. J. Johnstone, Superintendent State Printing, 1892.

Salmon and Trout of the Pacific Coast. (Pages 5–19.)